THE NEWTON OBJECT-LESSON HANDBOOK · 2

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The Newton Object-Lesson Handbook

WITH NOTES ON ENGLISH COMPOSITION

Part II

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GLASGOW AND DUBLIN
1901

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INTRODUCTORY.

A glance through the Second Science Reader will show that the book contains some information on common animals, on certain parts of well-known plants, and on a few very common substances.

It must be clearly understood that the reading lessons in this, as well as in the other books of the series, are not intended to take the place of oral object lessons, but rather to provide a useful means of revising lessons previously given by the teacher, and thus fixing on the memory the main points observed during the examination of the objects brought before the class.

It will be seen that all the objects selected for the lessons are such as may be met with without difficulty, either in town or in country. The animals introduced are all British, and may be obtained or observed with no further trouble or time than is expended in taking a short walk. The plants and the vegetable products, too, are to be gathered in almost every district, or purchased at a very low cost; and the common substances dealt with are such as may be found in almost every home. Hence there is no excuse on the part of the teacher for converting what should be an object lesson into a mere lesson of information.

Of course diagrams and pictures are useful in their place, but the best lesson illustrated by these means alone is not to be compared with an *object lesson* in which each child is taught to observe for itself, to make its own comparisons, and to draw its own inferences.

Thus it is intended that each object selected for the following

lessons should first be examined by the children themselves, with the aid of the teacher; and that the corresponding reading lesson should serve for revision, and as a means of fixing the main points in the memories of the children.

It is generally impossible to deal with as many observations and facts in a reading lesson of convenient length as would usually be dealt with in an object lesson; hence it will sometimes occur that the former, after all, provides only a partial recapitulation of the subject concerned; but the outline notes here furnished for the use of the teacher contain other points which may be introduced, at the teacher's discretion, according to the time allotted, and to the capabilities of the class to which the lesson is given.

In a few cases, it will be observed, the "objects" selected are such as could not be conveniently conveyed into the schoolroom; but there is no reason for departing from the principle previously laid down—that each lesson should, if possible, be illustrated by the object itself, and not by pictures and diagrams only. Such lessons could, and should, be the purpose of occasional short excursions to neighbouring fields, farmyards, manufactories, or local museums. In elementary schools the Code allows the time taken in such visits to be counted towards attendance.

The object lesson has always been used by good teachers as an instrument for adding to the child's vocabulary, and for helping it to acquire the power of expressing its thoughts. Indeed, this has too often been regarded as the main, if not the sole, utility of the object lesson.

In three little books for children, which are intended specially for use with the Newton Science Readers, Books I, II, and III, and which have been issued under the title *English Composition through Picture and Object Lesson*, an attempt has been made to carry this use of the object lesson a step further, and to make it the channel for definite instruction in sentence-making. To teachers, the advantages of using the object lesson in this way will be at once manifest. The definiteness of the subject on

which the child is called upon to make a statement, renders it admirably suited for use in a preliminary course of instruction in composition.

For the child other helps are given, the words to be used being also placed at the head of the composition lesson; so that what has hitherto been a very unsatisfactory, and, for the child, most tiresome part of the school-work, should by these aids be made interesting, easy, and profitable.

For teachers, notes of lessons for the corresponding composition books have been here added to assist them in economizing, as far as possible, the time and labour required for the lessons. With the composition lesson it is natural to conjoin the spelling or word-building lesson, and the notes on that subject here added are such as practical experience has shown to be most useful.

THE HORSE.

Requirements.—Picture of the horse. The skull of the horse, or a diagram of the skull. Diagram of the hoof. A horse-shoe. Horse-hair. Pieces of horse-hide with and without hair.

Subject Matter.	Method.
General Characters.—	
1. *Skin and Coat.*—Skin thick, and covered with hair. Coat smooth, and easily cleaned.	1. Show a piece of horse-hide, with hair attached; also a piece of tanned hide without hair.
2. *Neck.*—Neck arched, and has a beautiful mane.	2. Compare with the necks of other common animals.
3. *Tail.*—Long. Can be moved in all directions.	3. Elicit use of tail for knocking off the flies.
4. *Feet.*—Protected by hoofs. Hoofs protected by iron shoes, which are fixed to the hoof with iron nails.	4. Compare the hoof with our finger-nails. Elicit that the hoof, like our nails, has no nerves.
5. *Ears.*—Can be moved in order to catch sound better, or be shaken to drive away flies.	5. Compare with our own ears, and with the ears of other animals.
6. *Teeth.*—Sharp cutting teeth in the front of each jaw.	6. Compare the front (incisor) teeth with our own. Tell their use.
Behind these a space without teeth.	Explain that the "bit" lies in this space.
At the back of the jaw are broad grinding teeth.	Compare these teeth with our own molars.
Habits and Instinct.—	
1. *Intelligence.*—Knows its master and its master's voice. Very obedient. May be taught to do various things. Very docile.	1. Elicit the value of these qualities in a beast which is to serve man.
2. *Feeding.*—Food consists of oats, hay, grass, &c.	2. Name other herbivorous animals, and point out that the teeth in all are similar to those of the horse.
Seizes its food with its lips; bites it with its front teeth, and masticates it with the back teeth.	
Uses.—	
1. *The Live Horse.*—A beast of burden. Used in hunting and in warfare.	1. Note how the form of the back is adapted for riding.
2. *The Dead Horse.*—Skin made into leather. Bones into handles of knives and other articles. Hoofs used for making glue. Flesh used as food for other animals; and, in some parts, for human food.	2. Exhibit various articles and specimens illustrating the uses of the horse when dead.

NOTES FOR COMPOSITION LESSONS

(Pupil's Composition Book, page 3.)

I. Oral Work.

(1) Direct the attention of the class to the pictures in their composition books.

(2) Question them regarding each picture.

(3) Insist upon each answer being given in the form of a complete sentence.

(4) Write down the answers on the black-board, and underline the words to be noted for spelling.

(5) When two answers already written have to be joined together, *first* put in the given joining word between the two sentences; *next*, strike out of the sentences words repeated needlessly; *then*, re-write the new form of answer.

BLACK-BOARD

A. (1) The *horse* has an *arched neck.*
(2) The horse has a *long mane.*
(3) The horse has an arched neck *and* a long mane.

B. (1) The horse has a *smooth coat.*
(2) The horse *whisks off* the flies with its *tail.*
(3) The horse likes to *gallop* round the *field* with its *colt.*

C. (1) The horse can draw a *heavy load.*
(2) *Because* it is *very strong.*
(3) The horse can draw a heavy load *because* it is very strong.

D. (1) *Iron shoes protect* the horse's *hoofs.*
(2) The iron shoes are put round the *edges* of the hoofs.
(3) They are *fastened* to the hoofs with *long nails.*
(4) The iron shoes are put round the edges of the hoofs, *and* are fastened to them with long nails.

II. Spelling.

(1) Write out the underlined words on black-board.

(2) Draw attention to the long *o* sound of *oa* in *coat* and *load.* Get children to supply other examples as *goat, toad.*

(3) Impress the spelling of such words as *mane, field, edge,* by grouping with them other words of similar type obtained from the children as far as possible.

NOTES FOR COMPOSITION LESSONS.—*Continued.*

(4) *Whisks off.* Aspirate the *h* in *whisks* and let children imitate; get from them other words commencing with *wh*: *whiskers, what, which,* &c. Compare the *f* sounded in *off* with the *v* sound in *of (ov).*

(5) Write the words *because, protect, arched,* and *fastened* syllabically, and explain that only the *d* is sounded in the final syllable of the last two words.

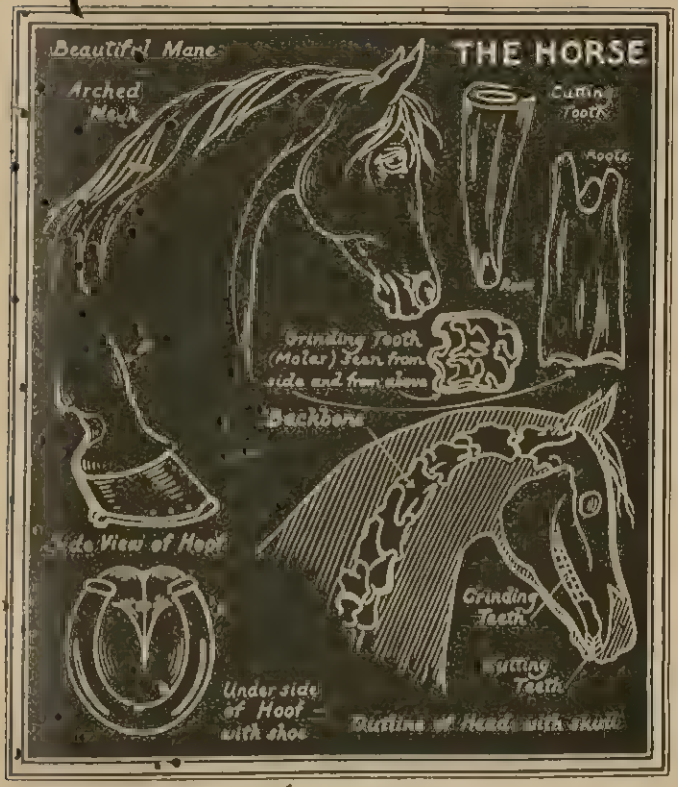
(6) Let children copy words on their slates.

III. **Written Tests.**

(1) Clean black-board. Arrange children in groups A, B, C, D, to write the exercises with corresponding letter.

(2) Correct carefully.

MEMORANDA.



Black-Board Summary.

General Characters.—

1. Skin thick; covered with hair.
2. Neck arched; and has a mane.
3. Tail long.
4. Feet with hoofs. Protected by shoes.
5. Ears can be moved.
6. Teeth.—Cutting teeth in front. Grinding teeth behind. A space between the two kinds.

Habits and Instincts.—

1. Very intelligent and docile.
2. Bites its food with its front teeth. Grinds it with the back teeth.

Uses.—

1. The live horse—
   A beast of burden, &c.
2. The dead horse
   Skin for leather.
   Bones for handles of knives, &c.
   Hoofs for glue.
   Flesh used as food.

NOTES FOR THE TEACHER.

The **horse** belongs to the family **Equidæ**, one of the order of hoofed quadrupeds. Besides the horse the family includes the **ass**, the **zebra**, and the **quagga**. These animals are all closely related to each other. The order is called also **Solidungula**, because each individual supports its weight on the **third toe** alone both in fore and hind feet. The last joint of each toe is broadened out into what is known as the "**coffin**" bone, closely surrounded **in front and at the sides by a single broad hoof.**

The native country of the horse seems to have been **South-Western** or **Central Asia**, and in Asia it was probably first domesticated. Notwithstanding its comparatively small head it is a very sagacious and particularly intelligent animal, and it is said to have a tenacious memory. Food and climate appear to aid in modifying it, the horses of southern countries, where the food is dry and often scanty, being almost invariably speedier and more enduring than those of northern countries where the climate is moist and the vegetation more abundant. Though the horse can endure very great cold, exposure to cold seems to affect its size, and the ponies of **Shetland** and **Iceland** are remarkably small.

There are a great many different breeds of horses, the most famous, perhaps, being the English race-horses, closely akin to the **Arab** and in almost every way a contrast to the **London dray** or the heavy **Shire horses**. What are called wild horses seem for the most part to be the descendants of animals that were once domesticated, but, having escaped, returned to the wild state. This is known to be true of the herds of wild horses that roam over South America. These have sprung from some Spanish horses and mares that were turned loose from Buenos Ayres when the colony was deserted in the sixteenth century. The herds of wild horses, "**tarpans**," that roam over the steppes round the Caspian and Sea of Aral seem also to have descended from animals that were once domesticated.

THE HEDGEHOG.

Requirements.—A tame hedgehog. Food for the hedgehog—a few pieces of raw beef. Skull of the hedgehog. A picture of the mother and her young.

Subject Matter.	Method.
General Structure.—	
1. *Skin.*—That of the back covered with sharp spines, and that of the under surface with soft hair.	1. Explain that the spines are modified hairs; and elicit why they are not necessary on the under side of the body.
2. *Nose.*—Pointed. Nostrils protected by a fold of the skin.	2. Show how the pointed nose and the protected nostrils are advantageous to a burrowing animal.
3. *Ears.*—Very small. Surrounded by soft hair. Can be moved.	3. Explain the use of the soft hair in preventing the entrance of particles of earth as the animal burrows.

THE HEDGEHOG.—*Continued.*

Subject Matter.	Method.
4. *Legs.*—Short. Toes with sharp and strong claws.	4. Elicit the convenience of short legs and the use of strong claws in a burrowing animal.
5. *Teeth.*—Small and sharp.	5. Show that the teeth are not adapted for chewing, but only for seizing and biting.
Habits.—	
1. *Feeding.*—Food consists of worms, insects, roots, &c. Food swallowed without mastication.	1. Let the children observe a tame hedgehog as it is feeding.
2. *Protective attitude.*—The hedgehog protects itself from danger by assuming the form of a ball, with spines projecting in all directions.	2. Exhibit the hedgehog in this attitude, and show the advantage of the soft hair on the under side of the body.
3. *Nocturnal habit.*—It shuns the light. Hides in dark holes by day, and comes out to feed in the evening.	3. Name other nocturnal animals, and point out that they are mostly burrowers.
4. *Hibernation.*—The hedgehog sleeps all through the winter without food.	4. Give other examples of hybernating animals.
Young Hedgehogs.—	
Several young in each brood. The young are naked and blind at first, and the spines grow gradually. The mother suckles its young.	Exhibit a picture of the hedgehog and its brood of young ones.

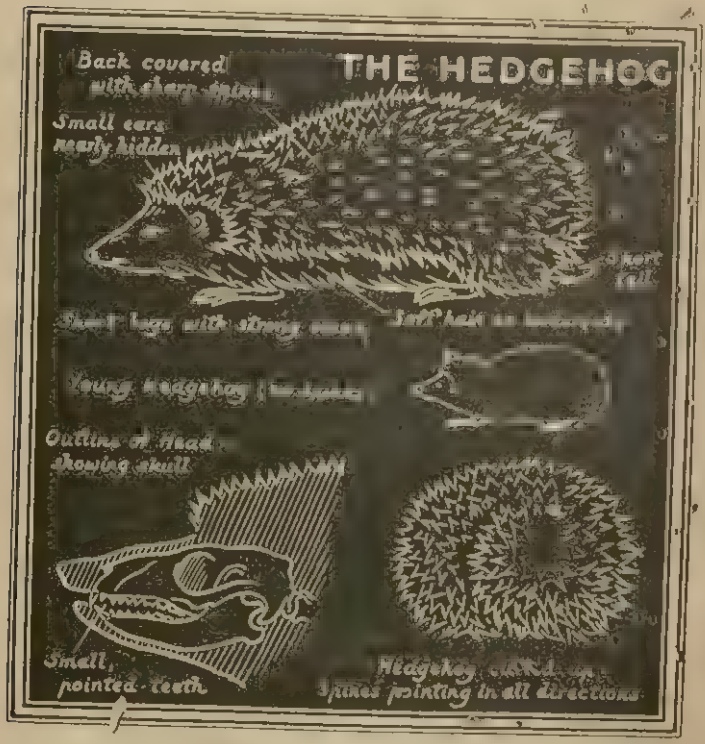
NOTES FOR THE TEACHER.

The hedgehog is a small insectivorous quadruped of the family **Erinaceidæ**. The common or European hedgehog (*Erinaceus europæus*) is one of the largest and most typical of the family. It grows to a length of about ten inches, being fully as large as a large-sized rat; the body, where not covered with spines, is clothed with a coarse yellowish-white hair, all except its long conical black snout. It has **thirty-six teeth**, twenty of which are in the upper and sixteen in the lower jaw, the central upper and lower **incisors** are longer than the others. As many as nineteen different species of hedgehogs have been recognized.

The hedgehog feeds on **insects, worms, slugs, and snails**, and in destroying these may be regarded as the friend of the farmer. It is often introduced into houses in towns because it destroys the **cockroaches** (*black-beetles*), which are such a plague in kitchens, and it is a deadly enemy to **frogs, toads, and snakes**, killing, according to some observers, not only the harmless common snake, but also the poisonous viper. There are, however, serious drawbacks to its usefulness; it attacks and kills young game; indeed, no small or weak animal comes amiss to the hedgehog, and it shows a very great fondness for eggs, which it devours whenever it has the chance.

The voice of the hedgehog is something between a grunt and a squeak; when tamed and kept in the house it is said to sometimes make itself disagreeable on account of its noise at night. It goes to sleep during the winter,

but, unlike many animals that do so, it lays up no stores for itself, save the fat which it stores up in its tissues during its season of activity. Its nest is composed of moss and dried leaves, which have the property, it seems, of keeping out the rain.



BLACK-BOARD SUMMARY.

Structure.—

1. Skin covered with spines above, and with soft hair below.
2. Nose pointed. Nostrils protected.
3. Ears small. Can be moved.
4. Legs short. Feet with sharp claws.
5. Teeth small and pointed.

Habits.—

1. Feeds on worms, insects, roots, &c.
2. Rolls in a ball when disturbed.
3. Hides by day. Comes out to feed at night.
4. Sleeps through the winter.

Young.—

Naked and blind at first.
Suckled by the mother.

HEN AND CHICKENS.

Requirements.—Picture of hen and chickens. Quill and down feathers. A hen's egg. Head, foot, and wing of the hen.

Subject Matter.	Method.
Structure.—	
1. *Feathers.*—Two kinds of feathers:— (*a*) Quill feathers, in wings and tail. (*b*) Down feathers, on breast, &c. Feathers form a very warm covering.	1. Exhibit the two kinds of feathers, and explain the uses of each kind. Elicit that this covering of feathers is a distinguishing characteristic of birds.
2. *Feet.*—Strong. Each with four toes, one of which is directed backwards and three forwards. Claws strong.	2. Show the foot of a hen, and compare with the feet of other birds.
3. *Beak.*—Short and strong. Made of a horny substance. No teeth. Food masticated in a gizzard.	3. Point out the uses of the beak in breaking and picking up food; also as a means of defence.
4. *The Gizzard.*—A hard and thick stomach, in which the food is ground by the two parts rubbing together. The mastication is assisted by the presence of grains of sand.	4. Describe the structure of the gizzard. If possible, show one, and explain how it acts as a substitute for teeth.
Habits.—	
1. *Feedings*—Food consists of worms, insects, seeds, &c., which are picked up with the beak and swallowed whole.	1. The children should have an opportunity of watching hens and chickens as they feed.
2. *Scratching.*—The hen scratches the ground to obtain her food, and teaches her chicks to do the same.	2. Show that the strong feet and claws are well adapted for scratching the ground. Name other scratching birds.
3. *Perching.*—The hen roosts on a perch by night. As she sits on the perch the tendons of the toes are pulled by the bending of the leg, and the toes are thus made to clasp the perch firmly.	3. Exhibit the foot of a hen, and show how the toes are bent together when the tendon at the joint is pulled.
Young. Young produced from eggs. Eggs kept warm by the hen for three weeks, at the end of which time the chicks are formed, and break the shell. The hen cares for the chicks till they are strong enough to shift for themselves.	Exhibit a hen's egg; and, if possible, compare with the eggs of other birds.

BLACK-BOARD SUMMARY.

Structure.—

1. Feathers of two kinds.
2. Feet strong, with strong claws.
3. Beak short and strong. No teeth.
4. Food masticated in a gizzard.

Habits.—

1. Feeds on insects, worms, seeds, &c.
2. Scratches in the ground for food.
3. Sleeps on a perch.

Young.—

Produced from eggs.
Protected by the hen.

NOTES FOR COMPOSITION LESSONS

(Pupil's Composition Book, page 5.)

I. Oral Work.

(1) Direct the attention of the class to the pictures in their composition books.

(2) Question them regarding each picture.

(3) Insist upon each answer being given in the form of a complete sentence.

(4) Write down the answers on the black-board, and underline the words to be noted for spelling.

(5) When two answers already written have to be joined together, *first* put in the given joining word between the two sentences; *next*, strike out of the sentences words repeated needlessly; *then*, re-write the new form of answer.

BLACK-BOARD

A. (1) The hen has *quill feathers* in her *wings* and *tail*.
(2) She has *down* feathers on her *breast*.
(3) The hen has quill feathers in her wings and tail, *but* she has down feathers on her breast.

B. (1) The hen lays her *eggs* in a *nest*.
(2) She keeps them *warm* by *sitting* on them.
(3) The hen lays her eggs in a nest *and* keeps them warm by sitting on them.

C. (1) The hen keeps her eggs warm to *hatch chickens*.
(2) The chickens are covered with *soft down* at *first*.
(3) The hen *shelters* her chickens under her wings.

D. (1) The hen has *strong claws* to *scratch* up the *soil* with.
(2) She scratches up the soil to find *worms* and *seeds*.
(3) The hen and chickens *eat* the worms and seeds for *food*.

II. Spelling.

(1) Write out the underlined words on the black-board.

(2) Draw attention to the short *e* sound of *ea* in *feathers* and *breast*; also the long *e* sound of *ea* in *eat*. Give other examples for comparison, as *weather*, *breath*, *beat*.

(3) *Hatch* and *scratch*. Get children to give other words ending in *atch*, as *match*, *latch*, &c. Group them on black-board.

sounded like *ay* in *clame*.

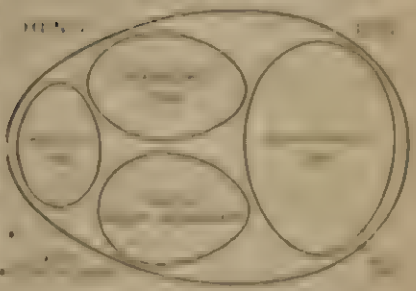
III. Written Tests.

(2) Correct carefully.

MEMORANDA.

[illegible] FOR THE TEACHER

[illegible] game birds



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THE HAWK.—*Continued.*

Subject Matter.	Method.
3. *Beak.* Very strong. Upper portion curved downward at the tip, forming a hook.	3. Compare the beak with that of the sparrow, the hen, &c.
4. *Sight.*—Very keen. Small objects discerned at great distances.	4. Show the importance of this keenness of vision in carnivorous animals.
5. *Feet.*—Legs and feet very strong. Four toes—three directed forwards and one backward. Claws retractile, strong, and sharp. Foot adapted for seizing prey.	5. Compare with the feet of birds previously examined. Show how the feet of the hawk are particularly adapted to the habits of the bird.
Habits.—	
1. *A bird of prey.*—Feeds on small birds and other animals. Watches for its prey while hovering in the air. Pounces upon it suddenly. Seizes it with its strong claws. Tears the flesh with its hooked beak.	1. Elicit all the striking adaptations of structure to habit in the hawk—powerful flight, keen vision, hooked beak, powerful claws.
2. *Nest and young.*—The hawk builds a nest of twigs and grass on a tree or cliff. It lays five eggs; and, like other birds, exhibits great maternal affection.	2. Exhibit a picture of a hawk's nest, if possible; and also of the egg (coloured).

Note.—The above description applies equally well to the merlin, the kestrel, and the sparrow-hawk, all three of which are common in Britain. The other British birds of prey are the eagle (seen occasionally in the rocky parts of Britain and Ireland), the buzzard, the marsh harrier, and the owl.

NOTES FOR THE TEACHER.

The hawk is a bird of prey of the **Falcon** family, a family which includes, besides the more nearly allied **buzzards**, **falcons**, and **eagles**, the **vultures** of the Old and of the New World. It is not such a powerful bird of prey as the eagle or the falcon. Hawks are remarkable for their long legs, and, in comparison with falcons and eagles, for their shorter wings and weaker flight. The male sparrow-hawk is of a bluish-slate colour above, the quills barred across with darker brown, while its white-tipped tail is barred with blackish brown. As is almost always the case with birds of prey the female sparrow-hawk is a good deal larger than the male, which is seldom more than 12 inches long, while the female measures nearly 16 inches, and has a length of wing of 9½ inches. The **merlin** and **kestrel** belong to a different division of the family from the sparrow-hawk, which is closely related to the **harriers**, while the merlin and kestrel, though smaller and differently coloured, are closely akin to the peregrine falcon, one of the noblest of the birds of prey.

NOTES FOR COMPOSITION LESSONS

(Pupil's Composition Book, page 7.)

I. Oral Work.

(1) Direct the attention of the class to the pictures in their composition books.
(2) Question them regarding each picture.
(3) Insist upon each answer being given in the form of a complete sentence.
(4) Write down the answers on the black-board, and underline the words to be noted for spelling.
(5) When two answers already written have to be joined together, *first* put in the given joining word between the two sentences; *next*, strike out of the sentences words repeated needlessly; *then*, re-write the new form of answer.

BLACK-BOARD

A. (1) The *hawk* has a *hooked beak.*
(2) The hawk can see its *prey* a long *distance* off.
(3) *Because* it has *keen eyes.*
(4) The hawk can see its prey a long distance off, *because* it has keen eyes.

B. (1) The *sharp claws* of the hawk are called *talons.*
(2) The hawk has *four* claws on each foot.
(3) They are *curved.*
(4) The hawk has four claws on each foot, *which* are curved.

C. (1) The *feathers* in the hawk's wings are long.
(2) The hawk's wings are *very wide* when they are *spread* out.
(3) The hawk *strikes* its prey with its talons.

D. (1) The hawk *seizes small birds* for its prey.
(2) The hawk *carries off* its prey *very swiftly.*
(3) *Because* it has *strong* wings.
(4) The hawk carries off its prey very swiftly, *because* it has strong wings.

II. Spelling.

(1) Write out the underlined words on the black-board.
(2) *Beak* and *spread.* Compare the sounds of *ea* in these words, and let the children give words to group with each, as *speak, bread,* &c.

NOTES FOR COMPOSITION LESSONS.—*Continued*

(3) Draw attention to the long *a* sound of *ey* in *prey*; compare *grey*, &c.

(4) *Skies.* Draw attention to the long *e* sound of *ie*; also to other words, as *receive, deceive.*

(5) Compare the *f* sound in *off* with the *v* sound in *of* (*oe*).

(6) Let children copy words on their slates.

III. Written Tests.

(1) Clean black-board. Arrange children in groups A, B, C, D, to write the exercises with corresponding letter.

(2) Correct carefully.

MEMORANDA.

BLACK-BOARD SUMMARY.

Structure.—

1. Feathers—a warm coat.
2. Body very light.
3. Beak sharp and hooked.
4. Sight very keen.
5. Feet strong, with sharp claws.

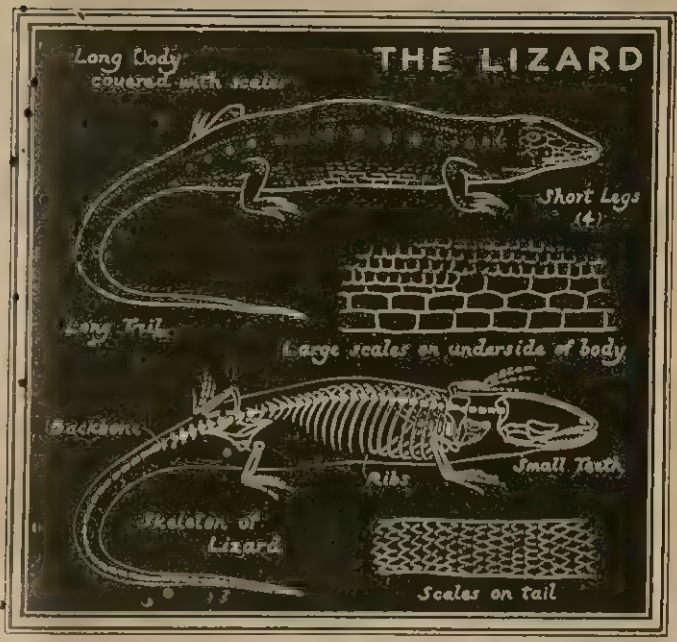
Habits.—

1. A bird of prey.
2. Young produced from eggs. Nest of twigs and grass.

THE LIZARD.

Requirements. A tame lizard, or a picture of the common lizard. Pictures of the crocodile, alligator, chameleon, or other animals of the lizard class for comparison. Picture of the skeleton.

Subject Matter.	Method.
Structure.—	
1. *General Form.*—Body long and narrow. Tail long and tapering Legs short; four in number. Feet with long, slender toes, terminating in sharp claws.	1. Exhibit pictures of other animals of the same class, and shew that they resemble one another more or less in general form, &c.
2. *Skin.*—Covered with shiny overlapping scales. Scales are cast off periodically, all in one piece. A new covering of scales is formed before the previous one is cast off.	2. Show a tame lizard, and also a cast "skin." Point out that the cast "skin" is really a covering of scales, corresponding with our outer skin—the epidermis.
3. *Skeleton.*—The lizard a vertebrate animal, with a well-developed internal skeleton.	3. Let the children name other vertebrates (animals with backbones).
4. *Breathing and Circulation.*—Breathes by lungs, as we do, but its blood is cold, as in all reptiles.	4. Name other cold-blooded animals, such as frogs, toads, and newts.
Habits.—	
Lives in banks and hedges, and on heaths and moors. Basks in the sun during the summer days. Hides in holes at night and during bleak weather. Very common in England. Hibernates.	Many interesting habits of the lizard may be observed if a tame one be procured. (Lizards are to be caught on heaths and banks almost everywhere, and are easily tamed. They may be kept alive for years with proper care and food.)
Runs swiftly. Feeds on insects and spiders.	
Easily tamed and perfectly harmless. If seized by the tail, it will render its tail brittle, and snap it off as a means of escape. A new tail grows in place of the former one. Will not do this when tame.	It is important that no confusion should exist between the lizard and the newt, as the two animals belong to quite distinct divisions of the vertebrates (see table below).
Young.—	
Generally eight to twelve young produced at one time. They undergo no metamorphoses like the young of frogs and newts, but are just like the parents, except in colour, which is very dark.	It must be observed that these characteristics of the young form one of the distinguishing features between newts and lizards—between batrachians and reptiles.
The young do not require a mother's care, but can shift for themselves from the moment of birth.	



BLACK-BOARD SUMMARY.

Structure.—

1. *Form.*—Body long. Tail long. Four short legs. Feet with slender toes and sharp claws.
2. *Skin.*—Covered with shining scales. Scales cast at intervals.
3. *Skeleton.*—Internal bony skeleton.
4. *Breathing,* &c.—Breathes by lungs. Blood cold.

Habits.—

Likes the sun. Feeds on insects and spiders. Sleeps all through the winter.

Young.—

Like the parent, but darker in colour.

NOTES FOR THE TEACHER.

Many different groups of animals, subdivided into different families and presenting great differences in appearance and habits, belong to the **Lizard order**. Some, like the blind-worm, are shaped like serpents, but differ from these in having a more or less distinctly marked shoulder-girdle and breast-bone. Their jaws cannot separate as the jaws of serpents do, nor is their throat extensible. Lastly, they usually differ from snakes in having movable

eyelids. Other forms are like the **crocodile**, but differ from it in not having bony-plate armour, and in having their teeth attached to the inner side or to the top of the jaw-bone, and not fixed in sockets like the crocodile. The tongues of the majority of lizards are like those of serpents—long, forked, and able to be thrust out; but in the case of some lizards the tongues are thick and fleshy, and not able to be protruded; while those of others are short and not able to be thrust out; and others again worm-shaped and freely protruding. Most lizards are flesh-eating, living on insects and other small soft bodied animals; but some forms feed entirely on vegetables. Though most lizards are **oviparous**, that is, lay eggs from which the young issue when hatched, some, like the common lizard, are **viviparous**, or bring forth their young alive.

Table of Classification

(showing the position of lizards in the animal world).

Vertebrates.	Mammals.	Warm-blooded.
	Birds.	
	Batrachians—Frogs, toads, and newts.	Cold-blooded.
	Reptiles—Lizards and snakes.	
	Fishes—Aquatic gill-breathing vertebrates.	
Invertebrates.	Animals without internal bony skeletons.	

THE TOAD.

Requirements. Large picture of toad and frog. A live toad and a live frog. If the lesson is given in early spring, the eggs of the toad may be obtained from ponds; if in late spring, or early summer, tadpoles should be procured from the same source. Failing these, a good diagram illustrating the metamorphoses of the toad should be used.

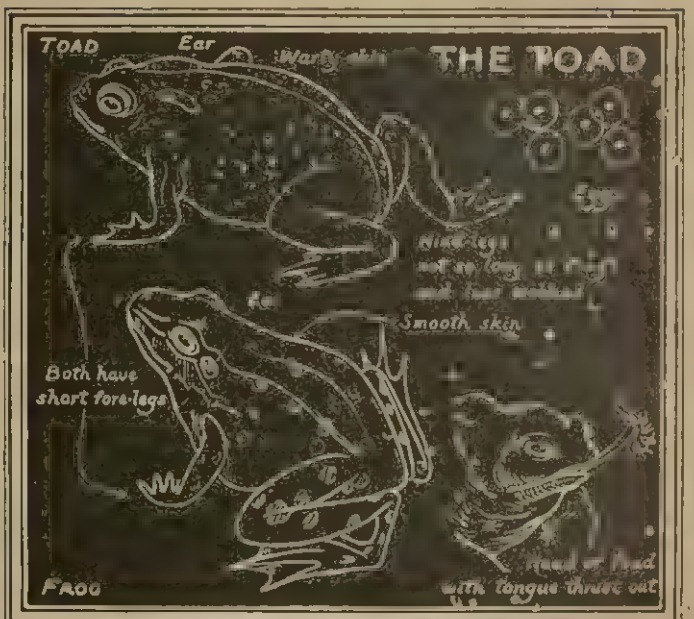
Subject Matter.	Method.
Form and Structure.—	
1. *Body.*—Short and thick. No neck.	1. Compare with the body of the frog. Elicit differences.
2. *Legs.*—Forelegs short. Hind-legs longer, but not so long as those of the frog. Hindfeet not so fully webbed as those of the frog.	2. Compare the legs and feet of the toad with those of the frog.
3. *Skin.*—Of a dull olive-brown colour above, lighter below. Cold, and covered with little warts.	3. Compare the skin of the toad with the smooth, yellowish skin of the frog.
4. *Eyes.*—Very bright and prominent.	4. Elicit the use of the prominent eyes in enabling the toad to look behind it.
5. *Ears.*—Not projecting. The drums of the ears are smooth, round spots behind the eyes.	5. Compare with our own ears, also with those of the frog.

THE TOAD.—*Continued.*

Subject Matter.	Method.
6. *Nostrils.*—Two small holes above the front of the mouth.	6. Show that the nostrils can be closed by folds of the skin.
7. *Mouth.*—Very wide. Tongue fastened to the front of the mouth; and, therefore, can be thrust far out. It has no teeth.	7. Compare with the frog. Be careful to note that the toad is not venomous, and that it is incapable of doing the least harm.
Habits.—	
1. *Breathing.*—The toad breathes through its nostrils. Cannot breathe with its mouth open. (See lesson on the Frog in Book I.)	1. Explain how the breathing is performed, and thus show why the mouth must be closed.
2. *Walking.*—The toad cannot jump so well as the frog, because its hindlegs are not so long and not so strong. It walks clumsily.	2. Let the children observe and compare the movements of the toad and the frog.
3. *Swimming.*—It cannot swim so well as the frog.	3. Elicit reasons for this, and let the children observe the difference.
4. *Feeding.*—Catches its prey with its tongue, which is covered with sticky saliva.	4. Point out the adaptation of structure to habit, explaining why the tongue is fastened in front.
5. *Hibernation.*—All through the winter the toad sleeps, without food, in damp holes.	5. Compare with the frog, and ask for other examples of hibernating animals.
6. *Young.*—The young are fish-like, and are called tadpoles. They gradually change to toads, going through the same stages as the frog. (See Book I.)	6. Illustrate the stages of the tadpole by means of specimens or pictures.

NOTES FOR THE TEACHER.

The **common toad** is a type of the great family **Bufonidæ**, one of the tailless **Amphibians** or **Batrachians**. It has no teeth, differing in this respect from the frog, from which it differs also in shape, and in the colour and texture of its skin. The body of the toad is swollen and heavy looking, its skin warty, its head large and flat, and its muzzle rounded. The toad was long popularly believed to be **venomous**; but is in reality a perfectly harmless creature. The belief arose from the fact that the skin of the toad gives off, no doubt as a protection against its enemies, an acrid fluid. They are really very useful animals, and destroy immense numbers of harmful insects. In spring the eggs are laid; they are laid in strings of three or four feet in length, and each egg is covered with a thick sticky coat of transparent albuminous matter. As the toad lays later in the spring than the frog, the toad tadpoles go through their changes of form while of smaller size than most of their kindred, and it is not till autumn that they come to land as little toads. There are nearly a hundred different kinds of toads, the family being found nearly all over the world. Of the three European species, only two are found in Britain, the common toad (*Bufo vulgaris*), and the rarer natterjack toad (*Bufo calamita*).



BLACK-BOARD SUMMARY.

Form and Structure.—

1. *Body.* Short and thick. No neck.
2. *Legs.*—Forelegs short. Hind-legs long.
3. *Skin.*—Dull olive-brown. Warty.
4. *Eyes.*—Bright and prominent.
5. *Ears.* Do not project.
6. *Nostrils.*—Above the mouth.
7. *Mouth.* Wide. Tongue fastened in front.

Habits.—

1. *Breathing.*—Breathe through nostrils.
2. *Walking.*—The toad walks clumsily, and cannot jump well.
3. *Swimming.*—Not such a good swimmer as the frog.
4. *Feeding.*—The toad catches its prey with its sticky tongue.
5. *Hibernation.*—It sleeps all through the winter.
6. *Young.*—The young pass through several changes.

NOTE FOR TEACHER.

Toads are not reptiles. Refer to the table of classification given in the last lesson. Reptiles do not undergo changes in form like the Batrachians or Amphibians.

NOTES FOR COMPOSITION LESSONS

(Pupil's Composition Book, page 9.)

I. Oral Work.

(1) Direct the attention of the class to the pictures in their composition books.

(2) Question them regarding each picture.

(3) Insist upon each answer being given in the form of a complete sentence.

(4) Write down the answers on the black-board, and underline the words to be noted for spelling.

(5) When two answers already written have to be joined together, *first* put in the given joining word between the two sentences; *next*, strike out of the sentences words repeated needlessly; *then*, re write the new form of answer.

BLACK-BOARD

A. (1) The *toad* has a *larger body* than the frog.
(2) Its *skin* is *covered* with *little warts*.
(3) The toad has a larger body than the frog, *and* its skin is covered with little warts.

B. (1) The toad's *hind*-legs are *longer* than its *fore*-legs.
(2) It has *webbed feet*.
(3) The toad's hind-legs are longer than its fore-legs, *and* it has webbed feet.

C. (1) The toad has *prominent bright eyes*.
(2) It has a *very wide mouth*.
(3) The toad has prominent bright eyes *and* a very wide mouth.

D. (1) The toad has a *long tongue*.
(2) The toad *thrusts* out its tongue to *catch insects*.
(3) The toad's tongue can hold the insects *because* it is *sticky*.

II. Spelling.

(1) Write out the underlined words on the black-board.

(2) Draw attention to the sound of *ar* (aw) in *warts*. Give other examples of the sound, as *war, warm*.

(3) Get children to give other words ending in *ind* to group with *hind*, as *find, mind*, &c. Deal similarly with *fore, catch*, &c.

NOTES FOR COMPOSITION LESSONS.—*Continued.*

(4) Build up the words *forehead* and *before* from *fore*.
(5) Show that *gh* in *bright* makes the *i* long. Compare *lit*, *light*.
(6) Let children copy words on their slates.

III. Written Tests.

(1) Clean black-board. Arrange children in groups A, B, C, D, to write the exercises with corresponding letter.
(2) Correct carefully.

MEMORANDA.

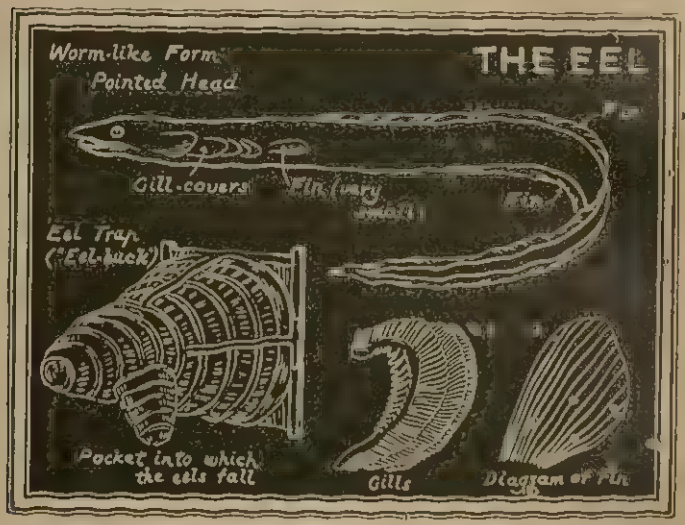
THE EEL.

Requirements.—Live eels in a large glass vessel of water. Large picture of the eel. Diagram illustrating the gills of a fish, one showing the structure of a fin, and a diagram or picture of an eel-trap.

Subject Matter.	Method.
Structure, &c.—	
1. *Form.*—The body of the eel is long and slender, and tapers at both ends—it is wormlike.	1. Show that the form is adapted to aquatic habits, and that it enables the eel to get into very small holes.
2. *Fins.*—A small fin on each side, behind the head; one at the tail; a long and narrow fin above and one below the body. Fins formed of a very thin skin, supported by thin rays.	2. Exhibit a diagram of a fin. Note how small the fins are compared with those of other fishes.
3. *Skin.*—The scales are so small that they cannot be seen without a magnifier. Skin very smooth, and covered with slime.	3. Compare the skin of the eel with that of the herring. Explain that the smoothness of the skin lessens resistance in the water.
4. *Gills.*—Like other fishes, the eel breathes by means of gills. Water contains air in solution. The water is taken into the mouth, and passed out under the gill-covers at the back of the head. The gills are richly supplied with blood, and the blood absorbs air from the water. This absorption can go on only as long as the gills are moist.	4. Show a diagram of the gills of a fish; or, better still, exhibit the gills of a herring or other fish of convenient size. Explain the difference between gills and lungs.
Habits.—	
1. *Home of the eel.*—The eel lives at the bottom of streams and rivers, where it hides under stones and among weeds.	1. Elicit that the form of the body enables the eel to pass into small holes and crevices, where it can hide and watch for its prey.
2. *Feeding.*—The eel feeds on worms and other small animals. It swallows its prey whole, as its small, sharp teeth are not adapted for mastication.	2. Note that none of the fishes masticate their food, but that their teeth are adapted for seizing and holding only.
3. *Swimming.*—Swims by means of its fins, and by an undulating motion of its body.	3. The children should observe the swimming and other movements of the eel.
4. *Migration.*—The eel can live for a long time out of water, and migrates from stream to stream, often covering considerable distances. It has pouches of fluid for keeping the	

The Eel.—*Continued.*

Subject Matter.	Method.
gills moist while it is out of the water. **Use.**— Used as food. Sometimes caught with a line, using worms as bait. More frequently caught in traps.	



Black-Board Summary.

Structure.—

1. *Form.*—Wormlike.
2. *Fins.*—Very small.
3. *Skin.*—Smooth and slimy. Scales very small.
4. *Gills.*—Absorb air from the water.

Habits.—

1. *Home.*—Lives at the bottom of streams and rivers.
2. *Feeding.*—Feeds on worms and other small animals.
3. *Swimming.*—Swims by its fins, and by bending its body from side to side.
4. *Migration.*—It can travel over the land.

Use.—

Used as food. Caught in traps.

NOTES FOR COMPOSITION LESSONS

(Pupil's Composition Book, page 11.)

I. Oral Work.

(1) Direct the attention of the class to the pictures in their composition books.

(2) Question them regarding each picture.

(3) Insist upon each answer being given in the form of a complete sentence.

(4) Write down the answers on the black-board, and underline the words to be noted for spelling.

(5) When two answers already written have to be joined together, *first* put in the given joining word between the two sentences; *next*, strike out of the sentences words repeated needlessly; *then*, re-write the new form of answer.

BLACK-BOARD

A. (1) We may *catch eels* in a *stream* or *river*.
(2) We may catch eels with a *gauze net*.
(3) We may catch eels with a gauze net in a stream or river.

B. (1) The eel has *two small eyes*.
(2) The eel has a *pointed nose*.
(3) The eel has two small eyes *and* a pointed nose.

C. (1) The eel has a *long thin body*.
(2) It has *two* small *fins behind* its head.
(3) The eel has a long thin body *with* two small fins behind its head.

D. (1) The eel has a *very smooth skin*.
(2) It can *twist* its *body round*.
(3) The eel has a very smooth skin, *and* it can twist its body round.

II. Spelling.

(1) Write the underlined words on black-board.

(2) Let children give other words ending in *atch* to group with *catch*. Deal similarly with the words *eels*, *stream*, &c.

(3) Compare *gauze* with *cause*, *caws*.

(4) *Twist*. Obtain from children other words commencing with *tw*, as *twin*, *twine*. Compare with *two* where the *w* is sounded as if it were *o*.

NOTES FOR COMPOSITION LESSONS. *Continued.*

III. Written Tests.

(1) Clean black-board. Arrange children in groups A, B, C, D, to write the exercises with corresponding letter.

(2) Correct carefully.

MEMORANDA.

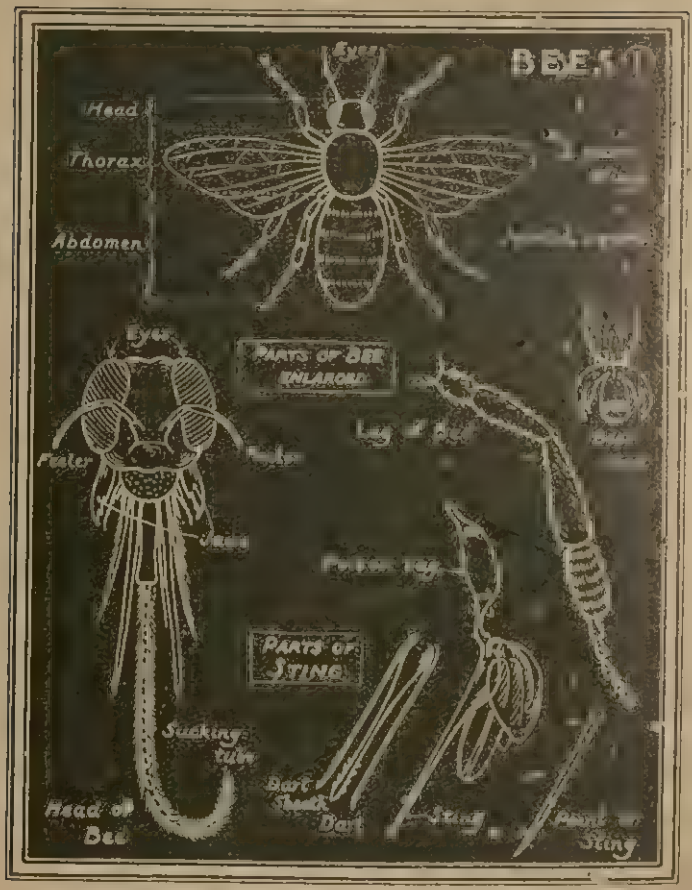
NOTES FOR THE TEACHER.

The common European sharp-nosed eel is the best known of the eel family, the **Murænidæ**. It inhabits most of the rivers, ponds, and lakes in this country, and is found, moreover, all over the world, except in the Arctic regions. Eels for the London market are largely imported from **Holland**. Eels may be kept in confinement, and even tamed; they are found to lie torpid during the winter, and to eat but little till the approach of the warm summer weather, when they begin to display an almost insatiable appetite. They are among the most voracious of the carnivorous fishes, devouring not only worms, on which they chiefly feed, but large quantities of spawn and fry, attacking other fishes, and when they can find no other food, swallowing each other. They are the strongest and swiftest of swimmers, and from their hiding-places in the mud, beneath some stone or overhanging rock, they dart with resistless fury on their prey. Even rats and snakes have been found in their stomachs. In autumn the full-grown eels descend the rivers for the purpose of depositing their spawn, whether in the brackish water at the mouth of the river or in the sea is uncertain. In spring the young eels ascend the rivers. The numbers that ascend may be guessed from the fact that more than 18,000 of these **elvers**, as the young eels are called, have been observed to pass a punt on the Thames in a single minute. The ordinary weight of an eel is from 3 to 4 lbs., but eels have been caught that weighed more than twenty pounds, and were more than five feet long. Eels are believed to be long-lived, and there are authentic instances of eels kept in captivity for over thirty years.

BEES. LESSON 1.

Requirements.—Picture of bees and the bee-hive. Diagram showing bees, much enlarged. Specimens of bees and honey-comb.

Subject Matter.	Method
Structure.	
1. *Body.* In three parts—head, thorax, and abdomen. Covered with hair.	1. Compare with other insects, and point out that this division of the body into three parts is characteristic of insects.
2. *Head.*—Provided with two large, compound eyes; a sucking-tube; and a pair of jaws.	2. Explain the nature of the compound eye of an insect.
3. *Thorax.* Composed of three ring-like segments. Each segment bears a pair of legs, and the second and third a pair of wings also.	3. Compare with the corresponding part of the body of the butterfly or other insect.
4. *Legs.*—Composed of several parts jointed together. Each foot terminates in a pair of hooked claws.	
5. *Wings.*—Each composed of a very thin and transparent membrane, supported by a few rays. The wings are placed one beneath the other on	



BLACK-BOARD SUMMARY.

Structure.—

1. *Body.*—Of three parts. Covered with hair.
2. *Head.*—Compound eyes, sucking-tube, and a pair of jaws.
3. *Thorax.*—Bears the legs and wings.
4. *Legs.* Composed of several jointed parts.
5. *Wings.* Formed of a thin membrane, with a few rays.
6. *Abdomen.*—Formed of several ring-like segments.
7. *Sting.*—A fine tube, with a poison-gland at its base.

BEES. LESSON 1.—*Continued.*

Subject Matter.	Method.
the back, when not in use. When spread for flying, the two wings of each side are locked together at their edges. 6. *Abdomen.*—Composed of several ring-like segments. The last segment provided with a sting. (The drone bees have no sting.) 7. *Sting.*—A very slender tube terminating in a sharp point. The base of the sting communicates with a gland which secretes an irritant poison. When the sting is used, some of the poison passes through it into the puncture made.	7. Explain the nature of the sting with the aid of a drawing.

NOTES FOR THE TEACHER.

The bee is a rather stoutly built insect, belonging to the **Apiarian** family of the **Aculeate** or **stinging Hymenoptera**. Owing to the value man places on its productions, **honey** and **wax**, it seems to have been early domesticated. It is a blackish-brown insect covered generally with grayish-brown hairs, the abdomen showing bands of a somewhat paler colour

BEES. LESSON 2.

Subject Matter.	Method.
Kinds of Bees.—Each hive contains three kinds:— 1. *Queen.*—The queen or female bee lays the eggs. There is only one in each hive. She seldom leaves the hive, and is always waited on and fed by the workers. She may be known by the longer tapering abdomen. 2. *Drones* or *Males.*—These may be known by their short and thick abdomen. A few hundreds exist in each hive—about one-twelfth the total number. The drones do not live more than a few months, are very sluggish, and do not store up food or build cells.	1. Exhibit pictures of the three kinds of bees.

BEES. LESSON 2.—*Continued.*

Subject Matter.	Method.
3. *Workers* or *Neuters.* — Some thousands of workers exist in each hive. They build the cells, gather food, feed the young, and store up food for winter use. The hindlegs are broad and flattened, and provided with rows of stiff hairs. These are used for collecting pollen from flowers.	3. Show a diagram of the hindleg of the worker, and explain the use of the "brushes". If necessary, explain the nature of pollen, illustrating by means of a flower.
The Hive.—The hive is the home and the storehouse of the bees. In it the workers construct hexagonal cells of wax. The wax is secreted by the abdomen of the bees. Some of the cells are used as cradles for the young, others for storing honey, and some for storing "bee-bread". The honey is prepared from the sweet juices obtained from flowers; and the "bee-bread", which is used to feed the young, is a mixture of honey and pollen.	Exhibit a piece of honey comb, and show how the cells are placed, base to base, and so inclined that the honey cannot easily run out.
Metamorphoses.—Bees, like most other insects, undergo changes in form. The young are white limbless grubs. These grow and develop into perfect bees.	Exhibit specimens of the various stages of the bee, if possible. If not, illustrate by means of a diagram.
Uses.—	
1. *To ourselves.*—We use the honey which the bees store up for themselves.	1. Explain that *honey* does not exist in flowers, but is prepared in the body of the bee.
2. *To flowers.* — In flying from flower to flower, the bees convey pollen from one to another, and thus assist in the fertilization of the seeds.	2. Explain the fertilization of flowers if the children are advanced enough to understand it.

NOTES FOR THE TEACHER.

During the winter and the spring the hive consists exclusively of the perfect female, the Queen Bee, and of a number of imperfect females or worker bees. In the spring the queen bee lays her eggs first in the worker cells, and then in the drone cells. She lays as many as 2000 eggs per day. Late in spring, or very early in summer, the workers prepare the larger queen cells, which are placed at the edge of the comb. In these the eggs from which queens are hatched are deposited, and the larvæ of these are fed by the workers with the rich and choice nourishment which forms only the first meal of the worker larvæ. As soon as the first of the young queens issues from her cell, the hive is thrown into a state of excitement, as two queens will not live in the same

[*Continued on page 45.*

NOTES FOR COMPOSITION LESSONS.

(Pupil's Composition Book, page 13.)

I. Oral Work.

(1) Direct the attention of the class to the pictures in their composition books.

(2) Question them regarding each picture.

(3) Insist upon each answer being given in the form of a complete sentence.

(4) Write down the answers on the black-board, and underline the words to be noted for spelling.

(5) When two answers already written have to be joined together, *first* put in the given joining word between the two sentences; *next*, strike out of the sentences words repeated needlessly; *then*, re-write the new form of answer.

BLACK-BOARD

A. (1) The *homes* of bees are called *bee-hives.*
(2) They are *placed* in *gardens.*
(3) The bees *store* up *honey* in the hives.
(4) The homes of bees are called bee-hives, *and* are placed in gardens.

B. (1) The bee has *two eyes.*
(2) The bee has *four wings.*
(3) The bee has *six legs.*
(4) The bee has two eyes, four wings, *and* six legs.

C. (1) The *mother* of the bees is called the *queen* bee.
(2) The *other* two kinds of bees are *drones* and *workers.*
(3) The *workers* make the *honey.*

D. (1) The bees *seek* for honey in the *flowers.*
(2) They go into the cups of flowers to *suck* the *sweet juices.*
(3) The bees make honey from the *sweet juices* of flowers.

II. Spelling.

(1) Write the underlined words on the black-board.

(2) Build up the word *placed*: *ace, lace, place, placed.*

(3) *Store, drones.* Get children to give other words ending in *ore* and *ones*, to group with these words, as *sore, tones*, &c.

NOTES FOR COMPOSITION LESSONS.—*Continued.*

(4) Compare *other*, *mother*, *smother*, and draw attention to the long *u* sound of *ui* in *juices*.

(5) Let children copy words on to their slates.

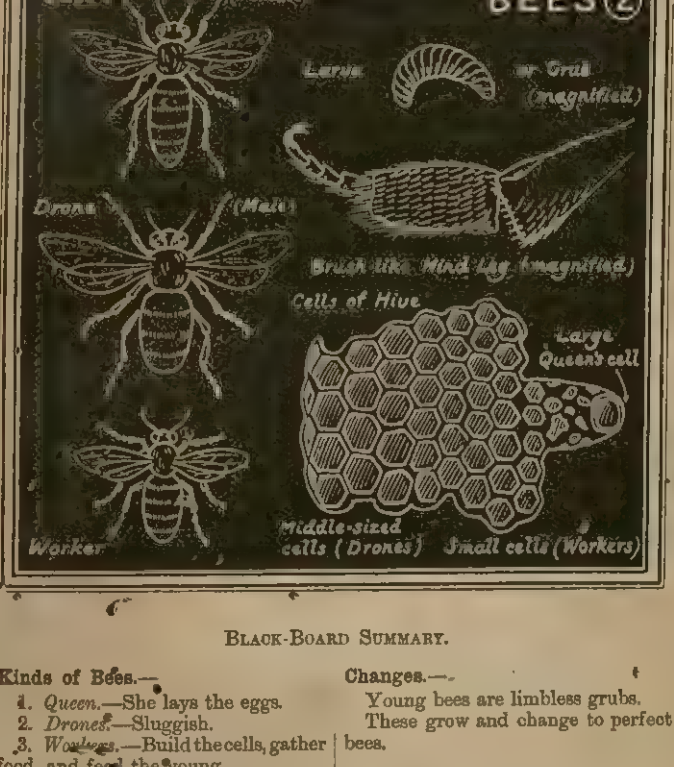
III. **Written Tests.**

(1) Clean black-board. Arrange children in groups A, B, C, D, to write the exercises with corresponding letter.

(2) Correct carefully.

MEMORANDA.

hive, and the old queen, gathering about her a portion of the workers, leaves the cell, and forms a new colony. These swarms number sometimes from twelve to fifteen thousand. This forming of new societies is repeated until the supply of young queens is exhausted, and then the workers fall upon the drones and put them to death. It is said that the first brood of workers in summer lives only for about six weeks, and then gives place to a new brood. The extreme limit of age of a worker bee is said to be not more than eight months; the queen bee, on the other hand, is known to live for five years, and during that time is said to produce more than a million eggs.



BLACK-BOARD SUMMARY.

Kinds of Bees.—

1. *Queen.*—She lays the eggs.
2. *Drones.*—Sluggish.
3. *Workers.*—Build the cells, gather food, and feed the young.

The Hive.—

Contains cells of wax.

Cells used as cradles, and for storing food.

Changes.—

Young bees are limbless grubs.

These grow and change to perfect bees.

Uses.—

Provide us with honey.

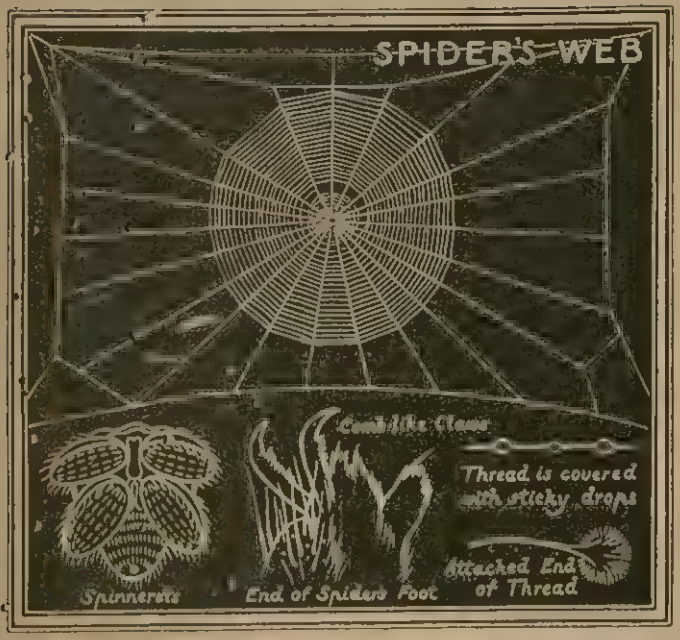
Help to fertilize the seeds of plants.

THE SPIDER'S WEB.

Requirements. Diagram of a garden spider's web, and an illustration showing the nature of the spinnerets. Bird-lime.

The children should examine the web of the garden spider; and, if possible, watch the spider while in the act of constructing it.

Subject Matter.	Method.
The Web.—The web is attached to bushes, palings, or other objects by several outer threads more or less irregularly disposed. Radiating threads pass from the centre of the web to the above. Lastly, a spiral thread connects all the radiating ones.	Call attention to the regular geometric pattern of the web, noting that the outer threads, which form the foundation of the web, are necessarily irregular, on account of the disposition of the convenient points of support.
The Spinning Organs.—The spinning organs of the garden spider are termed spinnerets. They are situated at the tip of the abdomen, and are six in number. Each consists of a little cell of sticky fluid, and the under surface of the cell is perforated with numerous small holes. When the spider applies its spinnerets to any object the sticky fluid adheres to that object; and, as the abdomen is withdrawn, a very thin semi-fluid fibre is produced from each perforation of the spinneret. All the fibres formed by each spinneret unite, while still fluid, to form one. Thus six threads are formed, one for each spinneret, and these again unite into one. The sticky fluid then hardens, forming a single thread of silk.	Exhibit a diagram of the spinnerets of the garden spider, showing the manner in which the fibres unite to form a single thread. Give examples of other sticky substances, such as bird-lime and thick molasses. Show that bird-lime can be drawn out into very fine fibres, and that these fibres may be made to unite into one.
Building the Web.—Various foundation threads are first made. These connect the convenient points of support. The radiating threads are next formed. The spiral thread is next formed, beginning at the centre. The spider makes use of its comb-like hind-claws in adjusting and uniting the various threads. Both the outer and the radiating threads are for support only; and the spiral thread, which has numerous little globules of a sticky fluid that does not readily solidify on exposure to air, forms the snare proper.	The children should watch the construction of the web if possible. If this cannot be done, the teacher should build up a diagram of the web on a black-board, making the various threads in their proper order. The sticky nature of the spiral thread should be demonstrated.



Black-Board Summary.

The Web.—
The outer threads support the web.
Other threads meet in the centre, and are joined by a spiral thread.

Spinnerets.—
The spinnerets are cells containing a sticky fluid.
This fluid passes out through small holes.
All the fibres unite into one thread.

Building the Web.—
The outer threads are spun first.
Then those which meet at the centre.
The spiral thread is formed last.
The spiral thread has sticky drops on it.

NOTES FOR THE TEACHER.

Spiders are distinguished from all other animals by their habit of spinning webs. Many **insects** spin for themselves cocoons, in which they pass from the **larval** to the complete (winged) stage; and some **mites** spin webs or cocoons

for their eggs, but the spinning organs of the spider are much more complete and are used for a much greater variety of purposes. They are used to form the silken bag in which the female spider places her eggs; for producing the silk with which she lines her nest; and more especially for forming the webs by means of which she catches her prey. The thread of the spider differs from that of insects in being composed of an immense number of very fine threads brought together while soft enough to unite into one. They use their threads also to form bridges, by which they may pass from one elevated position to another; to prevent themselves from falling when prowling about, and even as a means of transporting themselves through the air.

THE CRAB.

Requirements.—A crab, alive if possible. A picture showing the crab and other crustaceans, and a crab-pot.

Subject Matter.	Method.
Structure.—	
1. *Form.*—Body broad and flattened, with ten legs.	1. Elicit that the sharp edge of the body enables the crab to move through water with but little resistance.
2. *Covering.*—No internal bony skeleton, but protected and supported by a hardened skin. The skin is hardened by carbonate of lime, which is extracted from the sea-water. The skin is shed at intervals as the crab grows, each time revealing a new, soft skin beneath. This soft skin becomes hard in the course of a few days.	2. Name other animals similarly protected, such as the crayfish and the lobster, and explain that they belong to the invertebrates, or animals without backbones. Elicit that the hardened skin is not capable of extension, and must therefore be shed at intervals as the crab grows. Note that chalk is carbonate of lime.
3. *Legs.*—Composed of several parts jointed together. The front pair terminating in large, strong pincers, and the others in sharp claws. The legs are protected by hardened skin, but the parts are connected by a tough, flexible skin, which enables the limbs to be bent.	3. Show how the parts of the leg are joined together, and elicit the use of the flexible membrane at each of the joints. Compare the limb of a crab with that of an insect.
4. *Antennæ.*—The crab has a pair of antennæ or feelers.	4. Compare with the antennæ of insects.
5. *Eyes.*—The eyes are compound, like those of insects; and are mounted on the end of short, movable stalks.	5. Explain the nature of the compound eye, and elicit the use of the movable stalks.
6. *Tail.*—The tail of the crab is jointed, and is folded close against the under surface of the body.	6. Compare with the tail of the lobster, and also with the jointed abdomen of an insect.

THE CRAB.—*Continued.*

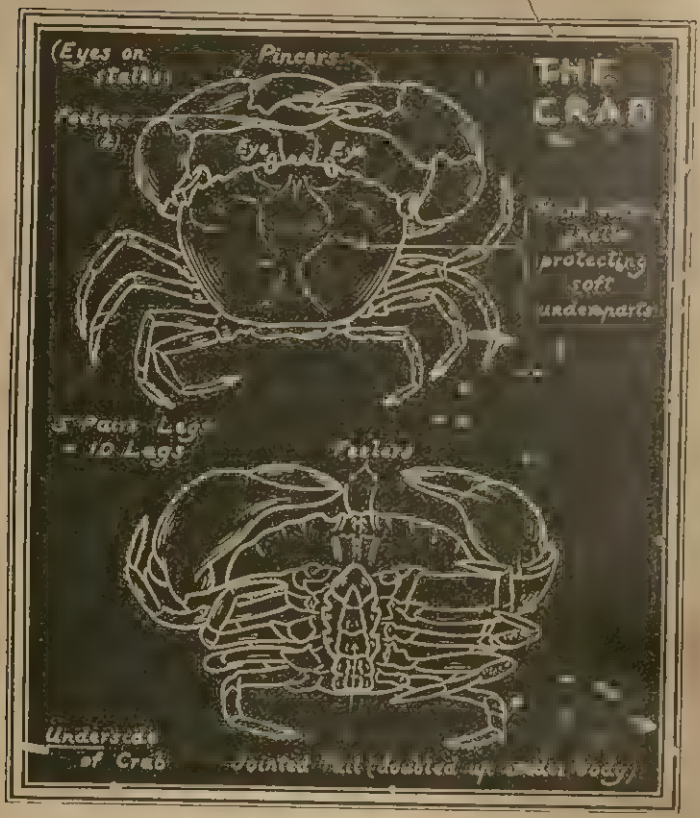
Subject Matter.	Method.
Habits.—	
1. *Locomotion.*—The crab can walk quickly with its ten legs; and it can swim, but not well. Its body being only a little heavier than water, and its claws being sharp, it can climb well over submerged rocks and weeds.	1. Why cannot the crab swim well? Elicit that its limbs are not broad and flat, and therefore not adapted for swimming. Contrast with the fins of a fish, and the feet of a duck.
2. *Feeding.*—The crab feeds on fish, shell-fish, &c. It holds its food in its pincers, and bites it with its strong jaws.	2. If the specimen used is not a very small one, the mouth and jaws can be shown.
3. *Breathing.*—The crab breathes by gills, like fishes; and, therefore, cannot live out of water after its gills are dry. It can live several days out of water if kept moist and cool.	3. Question on the differences between lungs and gills, as explained in previous lessons. Compare with the eel.
Uses.—	
1. *As Food.*—The crab is used as human food, and is caught in traps called crab-pots, made of wicker-work.	1. Exhibit a picture (or a model) of a crab-pot.
2. *Use in the Sea.*—The crab is useful in the sea, for it eats dead animal matter which would otherwise make the water putrid.	2. Elicit that the crab does the work of a scavenger. Remark on the importance of keeping both air and water as pure as possible.

NOTES FOR THE TEACHER.

The **crab** is the highest of the **decapods**, and the group which contains it is much more interesting than any other division of the **Crustaceans**. The edible crab (*Cancer pagurus*), with **carapace** about eight inches long by six broad, is the largest of British crabs.

The crab fishery is an important trade on many parts of the coast. It can be followed by people who are too old or too infirm to make a living as general fishermen. The crabs are caught in wicker traps called **crab-pots**, formed on the principle of the common wire mouse-trap, but with the entrance at the top. Many crabs, especially the sand and land forms, are rapid runners, others are burrowers, and others again are excellent swimmers. Among the British swimmers may be mentioned **Pennant's swimming crab** (*Portunus variegatus*), which has the last pair of legs shaped like an oar-blade, and **Henslow's swimming crab** (*Polybius Henslowii*), which is captured by the Cornish fishermen far off the coast, pursuing and devouring the **mackerel**.

The **common shore crab**, which is so abundant in the shallow water round our coasts, really spends much of its time out of the water. These crabs can be easily kept in small vessels of sea-water, and they soon become quite tame, and will come to be fed like other pets. These shore crabs when young moult very frequently, and the moulting is very complete. The crab in casting its shell parts not only with every joint and plate of its armour, with its feelers, its claws and tail, but the lining of its gills, of its stomach, of its eyes, and other parts is thrown off, so that the cast shell seems nearly perfect.



BLACK-BOARD SUMMARY.

Structure.—

1. *Form.*—Broad and flattened, with ten legs.
2. *Covering.*—A hardened skin.
3. *Legs.*—Formed of parts jointed together.
4. *Feelers.*—The crab has two.
5. *Eyes.*—On the ends of movable stalks.
6. *Tail.*—Jointed, and doubled under the body.

Habits.—

1. *Movement.*—Can walk and climb; but does not swim well.
2. *Feeding.* Feeds on fish and shell-fish.
3. *Breathing.* It breathes by gills.

Uses.—

1. *As Food.*—Crabs are used as food.
2. *Use in the Sea.*—They help to keep the water pure.

NOTES FOR COMPOSITION LESSONS

(Pupil's Composition Book, page 15.)

I. Oral Work.

(1) Direct the attention of the class to the pictures in their composition books.

(2) Question them regarding each picture.

(3) Insist upon each answer being given in the form of a complete sentence.

(4) Write down the answers on the black-board, and underline the words to be noted for spelling.

(5) When two answers already written have to be joined together, *first* put in the given joining word between the two sentences; *next*, strike out of the sentences words repeated needlessly; *then*, re-write the new form of answer.

BLACK-BOARD

A. (1) The crab's *body* is *broad* and *flat*.
(2) It is *covered* with *shell*.
(3) The crab's body is broad and flat, *and* is covered with shell.

B. (1) The crab has *ten jointed legs*.
(2) *Each* leg is covered with shell.
(3) The crab has ten jointed legs, *and* each leg is covered with shell.

C. (1) The *front pair* of legs have *pincers*.
(2) The *other* legs have *sharp claws* at the ends.
(3) The front pair of legs have pincers, *but* the other legs have sharp claws at the ends.

D. (1) The two little things like horns in *front* of the crab are *feelers*.
(2) The *under-side* of the crab is *softer* than the upper-side.
(3) The crab keeps its tail *doubled* up under its body.

II. Spelling.

(1) Write out the underlined words on black-board.

(2) Draw attention to the sound of *oa* (*or*) in *broad*. Compare *board*.

(3) Notice the short *u* sound of *ou* in *doubled*. Compare *troubled*.

NOTES FOR COMPOSITION LESSONS. *Continued*

(4) Let children give words ending in *air* to go with *pair*, *hair*, *stair*, &c. Treat other words in same way.

(5) Let children copy words on slates.

III. Written Tests.

(1) Clean black-board. Arrange children in groups A, B, C, D, to write the exercises with corresponding letter.

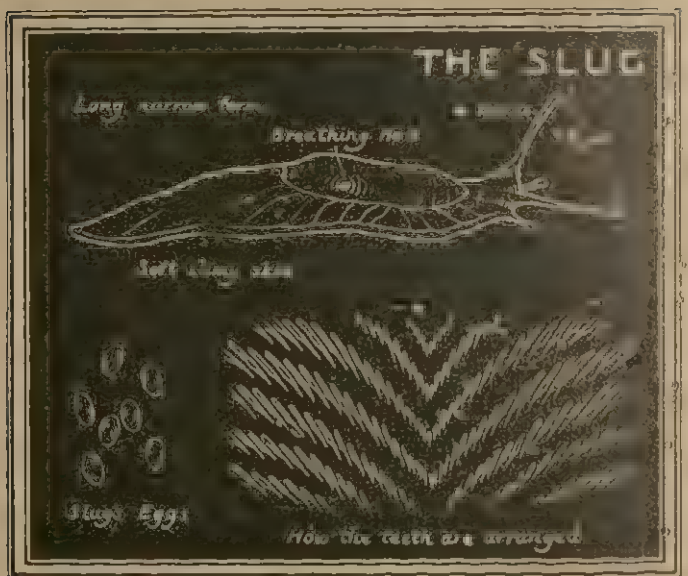
(2) Correct carefully.

MEMORANDA.

THE SLUG.

Requirements.—A live slug; a cabbage leaf; and a live snail. A picture of the slug, and a sketch of its teeth. Also a rasp.

Subject Matter.	Method.
Structure.—	
1. *General form.*—Body elongated and tapering before and behind. Convex above and flat beneath.	1. Compare the body of the slug with that of the garden snail.
2. *Skin.*—Soft and slimy. In some species much wrinkled. Colour whitish, yellowish, brown, or black, according to the species.	2. Show the sticky nature of the slime, and point out that the slug will sometimes let itself down from a tree by a thread formed of its slime.
3. *Head.*—Provided with four retractile horns—two longer and two shorter. Horns used as feelers, and the eyes are situated at the tip of the longer pair.	3. Compare with the head of a snail. Explain that the horns are pulled inside out as they are retracted; and imitate the movement by pulling the finger of a glove inside out by means of a string attached to the tip.
Mouth on the under side of the head, and provided with numerous small teeth in parallel rows.	Exhibit a diagram of the teeth.
Habits.—	
1. *Crawling.*—The slug crawls on its belly, moving itself along by a wave-like contraction of the muscles of its under surface. As it crawls it leaves behind it a streak of slime, which soon hardens on exposure to air.	1. The children should watch the slug as it crawls, and observe the slimy track made by it. They should also be allowed to see the wave-like contraction of the under surface as the slug crawls on a piece of window-glass.
2. *Breathing.*—The slug breathes by means of a lung, the air passing through an opening on the right side of the body.	2. Note that the slug is an air-breathing animal, and that it cannot live in water. Point out the pulmonary aperture on the right side.
3. *Feeding.*—It feeds on various vegetable substances, biting off small pieces with its teeth.	3. Show a rasp, and compare the action of the slug's teeth with that of the rasp.
4. *The Slug at rest.*—The slug does not like the light and heat of the sun. It hides under cover during the day, and crawls about and feeds at night. It goes to sleep all winter, taking no food.	4. The children should be encouraged to seek the slug in its haunts, and observe its habits in the garden or during their rambles.
Young. The young of the slug are produced from eggs. They do not undergo changes, like insects, but are, from the first, of the same form as their parents.	Slugs' eggs should be procured if possible. They may be found under stones and other objects.



BLACK-BOARD SUMMARY.

Structure.—

Form.—Long and narrow. Tapering.

Skin.—Soft and slimy.

Head.—Four horns. Eyes at the tips of the longer horns. Mouth on the under side.

Habits.—

Crawling.—The slug crawls on its flattened under surface.

Breathing.—It breathes by a hole.

Feeding.—It feeds on vegetable substances.

Resting.—It rests in cool and dark places.

Young.—

The young come from eggs, and do not change in form like insects.

NOTES FOR THE TEACHER.

The **air-breathing molluscs** (*Pulmonates*) in which the shell is internal or entirely absent are popularly called **slugs** (*Limacidæ*). On the front part of the back, near the head, these animals have a fleshy plate, the **mantle**, near the right edge of which is the opening or pore by which they breathe. Slugs closely resemble **snails** in structure; indeed, all the six families into which slugs may be divided seem to have been derived separately from shell-bearing ancestors. They love dark and damp places, and crowd together in cellars and outhouses and under planks and stones. As they hide themselves during

the day and only issue forth at night the damage done by them is often attributed to other creatures, though the presence of slugs may be recognized by streaks of slime in the neighbourhood. All the air-breathing molluscs can secrete mucus from their body, and in slugs this power is highly developed. When the animal is irritated the secretion of mucus is greatly increased, the secretion being partly defensive. They use the secretion in another way, for these animals will lower themselves from a tree or shrub by means of threads of mucus. Like snails, slugs often lift their heads and move their tentacles in search of objects around them. When they are frightened they draw their heads under their mantles and contract their foot. They lay their eggs, which look like small oval bags of jelly, in moist places. The eggs are from twenty to forty days in hatching, and the young slug attains its full size in a year.

ROOTS.

Requirements. Tap-roots, such as the turnip, carrot, and radish; and fibrous roots, such as those of the buttercup, primrose, grasses, &c. Various useful roots and root-products.

Subject Matter.	Method.
Forms of Roots.— 1. *Fibrous Roots.*—Composed of fibres, which are sometimes simple and sometimes branched. 2. *Tap-roots.*—These are thickened main roots. They are generally thick at the top, and taper off to a point below. They give off fibres.	The children should be allowed to examine the various roots, and be encouraged to describe them themselves.
Structure.— Roots are cellular, or are composed of fibres and cells. If formed of cells only, the root is soft and succulent, as in the case of the turnip and radish. The presence of fibres renders the root more or less tough and stringy. In the absence of fibres the root is brittle and snaps easily.	A few roots should be cut and broken in order that their structural characters may be observed.
Uses.— 1. *To the Plant.*—The root serves to fix the plant in the soil. It is also the means of absorbing plant food from the soil. Since the plant cannot move, it is essential that the root should spread to obtain sufficient food. Hence the root spreads out in the soil as the branches spread in the air.	Allow pure distilled water to run through some soil in a flower-pot. Apply heat to a portion of it, in a test-tube, and point out the bubbles of gas that are driven off.

ROOTS.—*Continued.*

Subject Matter.	Method.
The absorption is carried on by the soft terminations of the root-fibres and the root-hairs. Plants can absorb liquid only from the soil. This liquid consists of water, with various substances (gases and solids) dissolved in it. These form the plant-food.	Also evaporate a small portion of the water in a clean watch-glass, and show that a solid residue is left. These experiments prove that the soil contains soluble matter, and that the water in the soil contains dissolved solids and gases.
2. *To Ourselves.*—We use various succulent roots as food. Preparations from other roots are used as drugs.	Exhibit various useful root-products, such as ginger, chicory, beet-sugar, &c.

NOTES FOR THE TEACHER.

The root is generally that part of the plant which goes down into the soil. It is sometimes called the "**descending axis**". It is the first part protruded from the **embryo** or **seed** when germination begins, and in all plants is at first entirely cellular. The root grows in length by the continual addition of **new material near the tip.** The tip or **apex** itself consists of older and firmer tissue which forms a sheath or protecting covering for the **growing point** of the root. This covering is called the **root-cap**, and its presence distinguishes the structure of the root from the stem. The tip of all the secondary roots and rootlets is similarly protected. Root-hairs are developed on the root at a certain distance behind the root tip, and these increase the absorbing surface of the young root. Roots as a rule give rise to no other organs; as the root grows even the root-hairs farther back from the tip die away. Besides the absorption and carriage of water and food-salts to the plant and the fixing of the plant in its place, the roots of **biennial** and of **perennial** plants often store up **starch, fat, sugar,** and other reserve **food materials,** on which the plant, when it resumes its vegetative activity, can draw for support while engaged in seed or fruit production.

KINDS OF STEMS.

Requirements.—Various kinds of stems, of which the following would make a good selection: Nettle, hawthorn, grass, hop, pea, marrow, grape, strawberry, ivy, mint, potato, daisy.

Subject Matter.	Method.
Description of the Stems.— 1. *Nettle.* — Erect — sufficiently strong to support the plant. Green (herbaceous) and tough. Toughness due to the presence of fibres. Hairy. 2. *Hawthorn.*—Erect. Hard and woody. Covered with a brownish bark. Thorny.	In dealing with such a subject as this it is advisable to take the different specimens in turn, allow the children to examine them carefully, and then elicit from them the chief features of each, as well as the main points of likeness or difference. This being

Continued on page 64.

NOTES FOR COMPOSITION LESSONS

(Pupil's Composition Book, page 17.)

I. Oral Work.

(1) Direct the attention of the class to the pictures in their composition books.
(2) Question them regarding each picture.
(3) Insist upon each answer being given in the form of a complete sentence.
(4) Write down the answers on the black-board, and underline the words to be noted for spelling.
(5) When two answers already written have to be joined together, *first* put in the given joining word between the two sentences; *next*, strike out of the sentences words repeated needlessly; *then*, re-write the new form of answer.

BLACK-BOARD

A. (1) The root of the plant grows *below* the *ground*.
(2) It takes up *food* from the *soil*.
(3) The root of the plant grows below the ground *and* takes up food from the soil.

B. (1) The *kinds* of roots shown in the picture are *tap-roots* and *fibrous* roots.
(2) The fibrous roots seem made up of *many* strings or *fibres*.
(3) The little *threads* on the roots are called *rootlets*.

C. (1) The tap-roots are *soft* and *juicy*.
(2) The *radish* is a tap-root.
(3) The *carrot* and *turnip* are tap-roots.
(4) The radish, carrot, *and* turnip are tap-roots.

D. (1) The fibrous roots are *spread out* in the soil.
(2) The *buttercup* has a fibrous root.
(3) The *wheat* has a fibrous root.
(4) The buttercup and wheat have fibrous roots.

II. Spelling.

(1) Write the underlined words on black-board.
(2) Let children give words ending in *oil* to group with *soil*.
(3) Treat such words as *point* and *wheat* in same way. Make the children aspirate the *h* in wheat.

NOTES FOR COMPOSITION LESSONS. *Continued.*

(4) *Fibrous, fibre.* Give special attention to the final syllables, *ous* (*us*), *re* (*er*). Give other examples *various, nre*: *various, acre.*

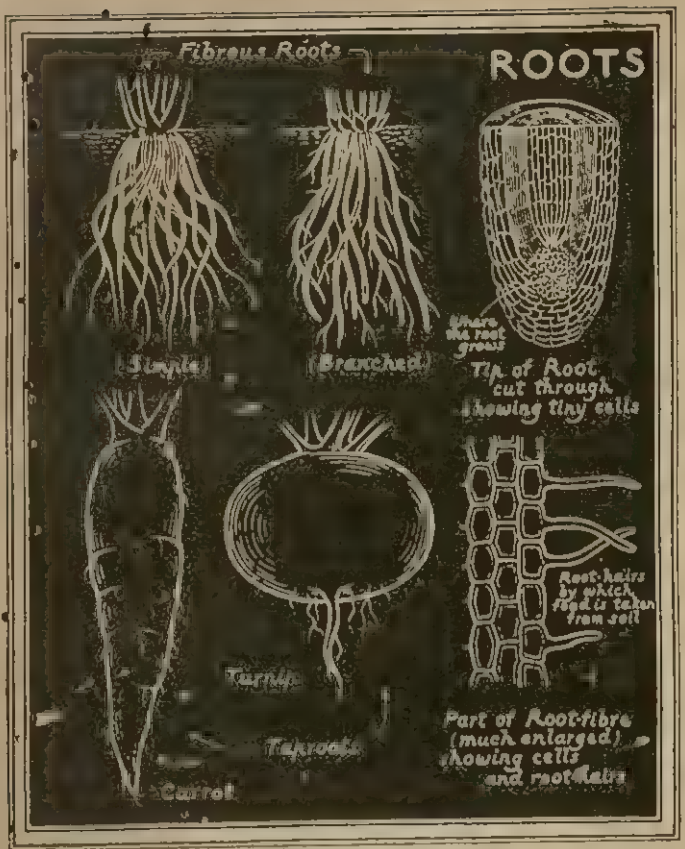
(5) Let children copy words on to their slates.

III. **Written Tests.**

(1) Clean black-board. Arrange children in groups A, B, C, D, to write the exercises with corresponding letter.

(2) Correct carefully.

MEMORANDA.



BLACK-BOARD SUMMARY.

Forms.—

1. Fibrous roots.—Branched and simple.
2. Tap-roots. Carrot, turnip, radish, &c.

Structure.—

Some roots fibrous. These are tough and stringy.

Others cellular.—Soft and juicy.

Uses.—

1. To the plant.—
   Fix the plant in the soil.
   Absorb plant-food.
2. To ourselves.—
   We use some roots as food.
   Others supply us with drugs.

KINDS OF STEMS.—*Continued.*

Subject Matter.	Method.

3. *Grass.*—Erect. Green. Jointed, and hollow except at the joints. Surrounded by sheaths formed by the leaves (blades).

4. *Hop.*—A weak stem. Could not support the plant without being itself supported. It twines round any object that comes within its reach, always turning round in the same direction.

5. *Ivy.*—Clings by means of little rootlets or suckers.

6. *Pea.*—Also a weak stem. Supports itself by means of tendrils. The marrow stem and the grape-vine are supported in the same way.

7. *Strawberry.*—The main stem of the plant is inconspicuous, being so short that the leaves and flowers appear to start direct from the root. The daisy, dandelion, and the primrose have similar stems.

The strawberry plant has also running stems (runners), which creep along on the ground. They are jointed, and a new plant will grow from the bud, which may be seen at each of the joints.

8. *Mint.*—The mint plant has an erect stem which bears the leaves and flowers; and also a running stem like that of the strawberry, except that it runs under the surface of the ground. The erect stem is green; but the underground stem, on account of the absence of light, remains white.

9. *The Potato.*—The potato plant has green erect stems which bear the leaves and flowers, and running underground stems. The potato which we eat is also a stem, called a *tuber*; and the eyes of the potato are buds.

10. *The Onion.*—The onion is a *bulb*. It is not really a stem, but a bud, for it is formed of thick, fleshy leaves. The lower, harder portion, from which the root fibres descend, is the true stem.

done, the specimens should be arranged in groups, placing those in the same groups which have features in common. The groups should be varied in order to illustrate the various ways in which stems may be classified.

The different modes of classification should then be written on the board somewhat in the manner given on the opposite page; and examples in each group should be named. The simple tables of classification will thus form a very convenient black-board summary of the lesson.

NOTES FOR COMPOSITION LESSONS

(Pupil's Composition Book, page 19.)

I. Oral Work.

(1) Direct the attention of the class to the pictures in their composition books.

(2) Question them regarding each picture.

(3) Insist upon each answer being given in the form of a complete sentence.

(4) Write down the answers on the black-board, and underline the words to be noted for spelling.

(5) When two answers already written have to be joined together, *first* put in the given joining word between the two sentences; *next*, strike out of the sentences words repeated needlessly; *then*, re-write the new form of answer.

BLACK-BOARD

A. (1) The *stems* of plants grow *chiefly above* the *ground.*
(2) They *bear* the *leaves* and *flowers.*
(3) The stems of plants grow chiefly above the ground, *and* bear the leaves and flowers.

B. (1) The *nettle* has a *hollow* stem.
(2) It is *covered* with *little hairs.*
(3) The nettle has a hollow stem, *which* is covered with little hairs.

C. (1) The *rose*-tree has a *solid* stem.
(2) It is covered with *sharp thorns.*
(3) The rose-tree has a solid stem, *which* is covered with sharp thorns.

D. (1) The stems of the nettle and rose-tree stand *upright.*
(2) The stem of the nettle *sends off stalks.*
(3) The stem of the rose sends off *branches.*
(4) The stem of the nettle sends off stalks, *but* the stem of the rose sends off branches.

II. Spelling.

(1) Write out the underlined words on black-board.
(2) *Chiefly.* Note the long *e* sound of *ie.* Give other examples, as *thief, brief.*

NOTES FOR COMPOSITION LESSONS *Continued*

(3) *Bear.* Get children to give words to group with this, as *pear.* Deal with *hairs, stalks, nettle,* in same way.

(4) *Upright.* Point out that the *gh* makes *i* long. Compare *lit, light, sit, sight.*

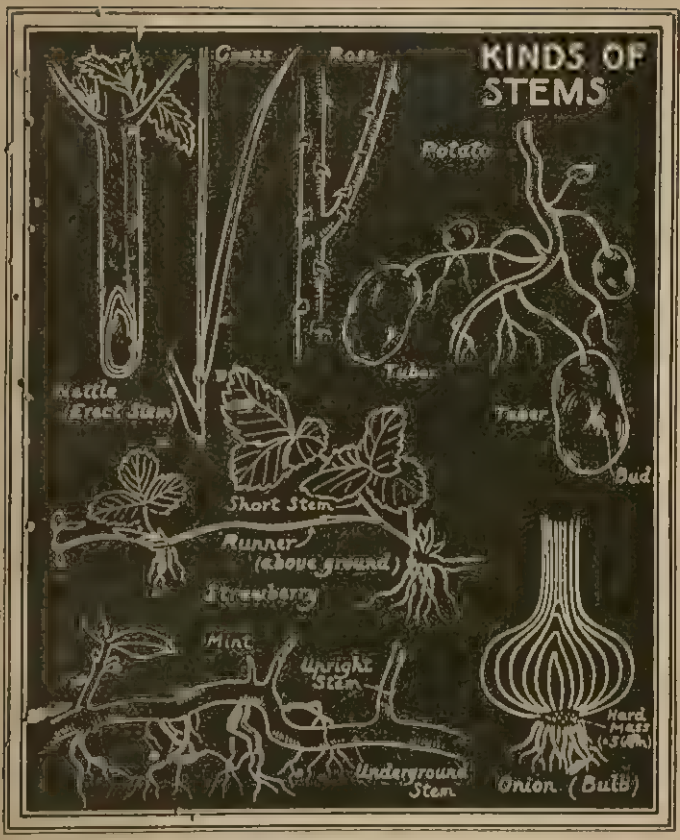
(5) Let children copy words on slates.

III. Written Tests.

(1) Clean black board. Arrange children in groups A, B, C, D, to write the exercises with corresponding letter.

(2) Correct carefully.

MEMORANDA.

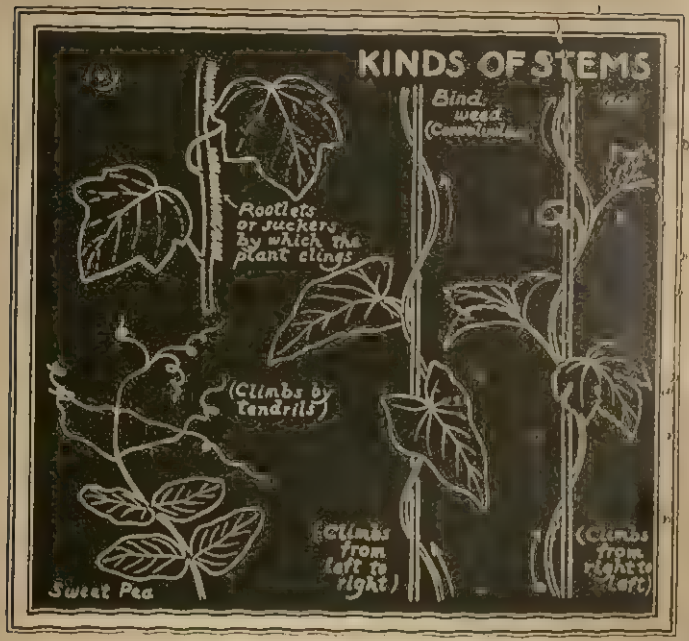


Black-Board Summary.

Kinds of Stems.

1. Erect—standing upright. Prostrate—lying on the ground. Climbing—requiring support.
2. Green and herbaceous. Strong, brown, and woody. White and soft.
3. Climbing stems. By tendrils. By twining. By suckers.
4. Runners. On the ground. Under the ground.
5. Long stems. Short stems.
6. Fibrous stems. Stems without fibres.

See diagram on p. 68.



NOTES FOR THE TEACHER.

The subject "Kinds of Stems" is a very difficult and very complicated one. The division here given does not claim to be exhaustive, but claims to be such as children, with a little direction, could be brought to make for themselves from the examination of a selected number of stems. Of erect stems, the name given to the close-jointed grasses and sedges (*culm*) might be given to the children; also *caudex*, the name given to the trunk of palms, tree-ferns, and the like. In the case of climbing stems, the attention of the children might be directed to the fact that of the **twining stems** some ascend by coiling with the sun (*right to left*), as the hop, and others by coiling against the sun (*left to right*), as the bindweed (convolvulus). Among climbing stems, **leaf climbers** may be distinguished from tendril climbers. The name **runner** is usually given only to the naked and tendril-like part of the stem which lies on the ground, and which roots at the tip, develops a bud, and so produces a new plant. The **underground stems** are almost as diverse as the **aerial**. They are classed as **root-stocks** (*rhizomes*), that is, stems which lie on the ground or are buried beneath it, and which at irregular intervals—at the *internodes*, or beginning of a new node—send off roots from the under part, and produce from the upper some kind of aerial stem; **tubers**, which may be regarded as thickened portions of the root-stock, usually including several *nodes*; **corms**, which may be regarded as solid bulbs; and **bulbs**.

NOTES FOR COMPOSITION LESSONS

(Pupil's Composition Book, page 21.)

I. Oral Work.

(1) Direct the attention of the class to the pictures in their composition books.

(2) Question them regarding each picture.

(3) Insist upon each answer being given in the form of a complete sentence.

(4) Write down the answers on the black-board, and underline the words to be noted for spelling.

(5) When two answers already written have to be joined together, *first* put in the given joining word between the two sentences; *next*, strike out of the sentences words repeated needlessly; *then*, re-write the new form of answer.

BLACK-BOARD

A. (1) The stem of the *strawberry* grows *along* the *ground.*
(2) It is *called* a *runner.*
(3) The stem of the strawberry grows along the ground, *and* is called a runner.

B. (1) The strawberry runner takes *fresh root* at *every joint.*
(2) It sends up *new leaves* at every joint.
(3) The strawberry runner takes fresh root at every joint *and* sends up new leaves.

C. (1) The *mint* stem grows *under* the ground.
(2) The mint stem sends off *root-threads* from the *under parts.*
(3) The mint stem grows under the ground, *and* sends off root-threads from the under parts.

D. (1) The *potato plant* has stems *above* and *below* the ground.
(2) The *potatoes* grow on the stems underground.
(3) The potato plant has stems above and below the ground, *but* the potatoes grow on the stems underground.

II. Spelling.

(1) Write the underlined words on black-board.

(2) *Joint, threads.* Let children supply words to group with these, as *point, leads,* &c. Deal similarly with other words.

NOTES FOR COMPOSITION LESSONS *Continued*

(3) Build up the words *strawberry*, *potatoes*, and *runner* by syllables.

(4) Let children copy words on slates.

III. Written Tests.

(1) Clean black-board. Arrange children in groups A, B, C, D, to write the exercises with corresponding letter.

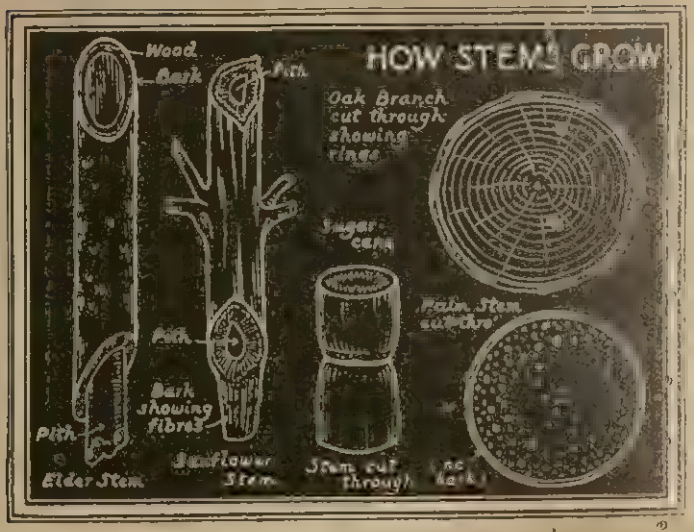
(2) Correct carefully.

MEMORANDA.

HOW STEMS GROW.

Requirements.—A twig of elder, or other tree, of one season's growth; a section of the branch of a tree showing more than one ring of wood; the stem of a sunflower; a section of a palm; and a piece of cane.

Subject Matter.	Method.
The Elder Stem.— The elder stem consists of three parts—pith, wood, and bark. The pith is very soft, moist, and composed of minute cells. The wood is strong and fibrous, the fibres being the tubes through which the sap passes. The bark forms an outer protective layer. In a stem of one season's growth the wood is thin, and consists of a single ring. In an older stem there are two or more distinct rings of wood, each ring representing one year's growth; and thus the age of the stem may be ascertained by counting the rings. A new ring of wood is formed each summer outside the older wood, and underneath the bark; hence the elder is an example of the *exogenous* or outward-growing trees. The bark is necessary for the protection of the young wood. All our forest trees are also exogenous. In an old branch, or the trunk of such a tree, rays of pith (*medullary rays*) may be seen radiating from the centre. In most exogens the veins of the leaves form a network.	Pieces of the stem, of different ages, should be cut with a share knife or a fine saw, and distributed to the class. The descriptions should be given by the children rather than by the teacher. Pieces should also be split and broken, in order to test the character of the wood and of the pith. The rings of wood will not be distinct unless the stems are cut with a clean and smooth section. Pieces of palm or cane (or both) should be dealt with in the same manner, and the stems should then be described as before. The table of characters given on the next page will form a very suitable black-board summary of the lesson.
The Palm and the Cane.— In palms and canes there is no central pith, and no true bark. The wood exists in the form of bundles of fibres surrounded by cells, and not in rings. The new wood is not formed on the outside, but within the stem. The oldest and hardest wood forms the outside. This mode of growth is termed *endogenous*; and the palm and canes are called *endogens*. The leaves of endogens have parallel veins. Grasses belong to this group.	



BLACK-BOARD SUMMARY.

Stems.
- Outward-growing.
  - Bark outside.
  - Pith in the middle.
  - One or more rings of wood between the pith and the bark.
- Inward-growing.
  - No true bark.
  - No pith.
  - Wood in small bundles, and not in rings.

NOTES FOR THE TEACHER.

The names **outward-growing** and **inward-growing**, or **exogen** and **endogen**, have been objected to because the second is not appropriate. It is true that in exogens the **cambium layer**, or layer between the bark and the wood, gives rise to a **layer of cork**, a **layer of wood**, and a **new cambium layer**, the layer of wood being deposited outside the previous woody part of the stem (see Book I.). The newer wood bundles of an **endogenous** stem, however, are variously mixed with the old, and it is not accurate to say that the older bundles occupy the surface, while only new ones are formed at the centre. In some palms there is a decided rind or false bark, and the whole centre of the **internodes**, when it is not hollow, is filled with a **true pith**. Annual endogenous stems increase in diameter by general growth till they reach their full size, and woody endogenous stems grow in a similar way for a time. In exogens, rays of pith radiate from the centre to the circumference, dividing the wood into sections. The wood of endogenous stems is hardest towards the circumference, and softer towards the centre, where even in old plants it is often largely mixed with pith.

NOTES FOR COMPOSITION LESSONS

(Pupil's Composition Book, page 23.)

I. Oral Work.

(1) Direct the attention of the class to the pictures in their composition books.
(2) Question them regarding each picture.
(3) Insist upon each answer being given in the form of a complete sentence.
(4) Write down the answers on the black-board, and underline the words to be noted for spelling.
(5) When two answers already written have to be joined together, *first* put in the given joining word between the two sentences; *next*, strike out of the sentences words repeated needlessly; *then*, re-write the new form of answer.

BLACK-BOARD

A. (1) The *ivy* is a *climbing plant.*
(2) The *sweet-pea* is a climbing plant.
(3) The ivy *and* the sweet-pea are climbing plants.

B. (1) The *little rootlets* on the *ivy-stems cling* to the wall.
(2) The little rootlets are called *suckers.*
(3) The little rootlets on the ivy-stems cling to the wall, and are called suckers.

C. (1) The *sweet-pea* has a *weak* stem.
(2) It is *supported* by *sticks.*
(3) The sweet-pea has weak stems, *so* it is supported by sticks.

D. (1) The *curling threads* on the sweet-pea are called *tendrils.*
(2) The tendrils *twine* round the sticks.
(3) The tendrils twine round the sticks to *hold up* the plant

II. Spelling.

(1) Write out the underlined words on the black-board.
(2) *Climbing.* Build this word from *limb.* Draw attention to the silent *b*, and to the change in the *i* sound when *e* is added to *limb.* Give other examples, as *numb, numbing.*
(3) Let children give words ending in *ea* to group with *pea.*
(4) Build up the word *supported* from *or, por, port,* &c.
(5) Let children copy words on slates.

NOTES FOR COMPOSITION LESSONS.—*Continued.*

III. Written Tests.

(1) Clean black-board. Arrange children in groups A, B, C, D to write the exercises with corresponding letter.

(2) Correct carefully.

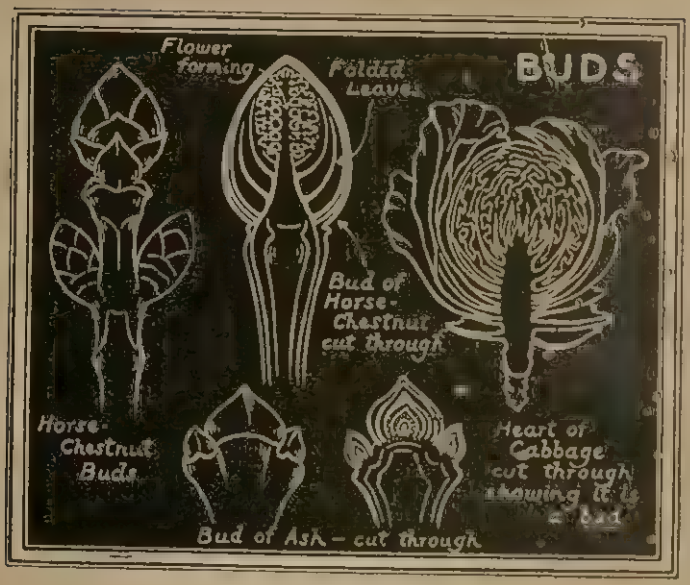
MEMORANDA.

BUDS

(A Lesson for Spring-time).

Requirements.—A variety of buds from trees and plants—some quite closed, and some opening. The selection should include buds covered with scales, hairy buds, and some covered with gum. A very sharp knife will also be required for making sections.

Subject Matter.	Method.
What is a Bud?— A bud is a young branch. It consists of a number of young leaves, compactly folded; and, within the folded leaves, a rudimentary branch is concealed. In some buds, such as those of the lilac and the horse-chestnut, the future flowers may be seen distinctly on making a section. A single bud gives rise to a branch, with its leaves, flowers, fruit, and seeds. Some buds do not develop into perfect branches, but give rise to thorns or tendrils	This question should be answered by the class, after a number of buds in different stages of development have been examined. The difference between ordinary buds and flower-buds should be clearly pointed out.
How Buds are Protected.— Buds are really formed in the autumn, and remain dormant during cold weather; hence they require some kind of protection. Some are protected by scales, which completely cover them, and keep out the rain. Others are protected by a covering of soft hairs. Some of the scale-covered buds are covered with a sticky resinous or gummy substance, which is perfectly waterproof.	Here, again, the information should be given, as far as possible, by the children themselves after examining a suitable variety of buds. The necessity of protection from frost should be explained.
Structure of a Bud.— If we make sections of buds, we may learn how the parts forming it are folded and packed together. The young leaves are often folded like a sheet of writing paper; some are wrapped round and round each other. Sometimes they are curled up spirally, and frequently they are doubled in a zigzag fashion.	A number of sections of buds should be passed round. For this purpose large buds should be selected, and the sections should be transverse in some cases, and longitudinal in others. The heart of a small cabbage should be similarly cut and examined, thus showing that the cabbage is a bud.



BLACK-BOARD SUMMARY.

What is a Bud?—

It is a young branch.

It consists of folded leaves, and other parts of the future branch.

How Protected.—

Buds are formed in the autumn, and require protection during the winter.

Some are protected by hairs, some by scales, and some by a kind of gum.

Structure.—

The leaves of a bud are folded up in various ways, and are closely packed together.

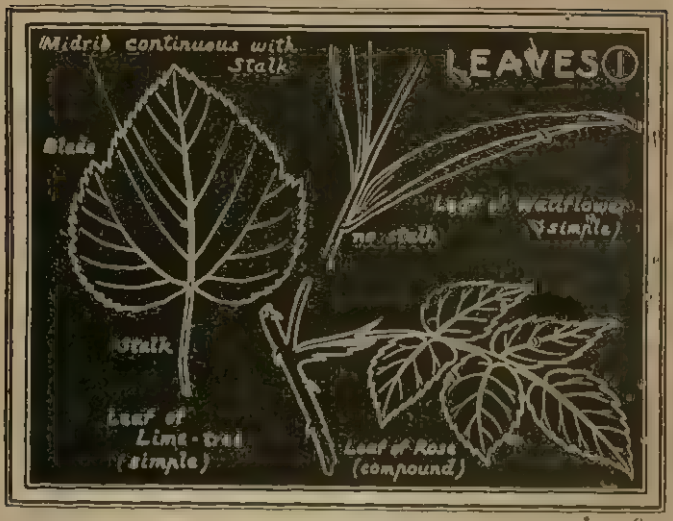
NOTES FOR THE TEACHER.

A bud is really a very short stem, with the leaves lying closely above one another. These leaves, or the scales which correspond to leaves, usually develop first. Buds that are at the end of a stem or a branch are called **terminal**, and those that are in the upper angle, formed by the leaf with the stem or branch, are called **axillary**. Buds usually appear in these positions: the *terminal* bud serves to continue the stem, and the *axillary* bud usually grows into a branch. Buds may also be grouped as **leaf-buds**, **mixed buds**, and **flower-buds**.

LEAVES. LESSON 1.

Requirements.—A number of leaves, of different forms—some simple and some compound. The leaves selected should also exhibit different kinds of surface (rough, smooth, hairy, bright, &c.), and a variety of edges (toothed, saw-like, crenate, spiny, &c.). The following common leaves would make a good selection:—Laurel, nasturtium, oak, lilac, elm, cuckoo-pint, dandelion, horse-chestnut, rose, primrose, wallflower, iris, willow, ground-ivy, ivy, fir.

Subject Matter.	Method.
General Description of a Leaf.— A leaf generally consists of a stalk (*petiole*) and a blade. The midrib, running through the centre of the leaf, is usually continuous with the stalk; and veins branch out from it. Some leaves have no stalk, but sit on the stem. They are termed *sessile* leaves. When a leaf is divided into two or more parts, each of which has its own stalk, it is called a *compound* leaf.	A typical leaf, such as that of the elm, lime, or beech, should be given to each child, who should be encouraged to observe and describe it. The wallflower leaf may be chosen to illustrate the sessile leaves, and a rose leaf to illustrate the compound.
Form and Surface of Leaves.— Leaves exhibit a great variety of form and surface. The principal forms are—circular (orbicular), oval, ovate, heart-shaped (cordate), arrow-shaped (sagittate), lance-like (lanceolate), oblong, rhomboid, linear (long and narrow), angular, hand-shaped (palmate), finger-like (digitate). The edges may be plain, toothed, saw-like (serrate), scalloped (crenate), spiny, or deeply and irregularly notched. The tip of the leaf may be sharp (acute) or blunt (obtuse). The surface, rough, smooth, hairy, shiny.	For the illustration of this part of the lesson a great variety of leaves should be used; and each leaf should be examined and described separately by the children. Drawings should also be made of all the principal forms. After the leaves have all been described separately, they may be classified – 1. As simple and compound, 2. According to form, 3. According to their edges, 4. According to their surfaces, 5. According to their apices, the exercises being performed by the children.



BLACK-BOARD SUMMARY.

Leaves.—
- Consist of
  - Stalk (some leaves have no stalk)
  - Blade.
- Kinds.
  - Simple.—Only one blade.
  - Compound.—Two or more blades with separate stalks.

Forms of Leaves.—
- Here name the different forms examined, and draw a B.-B. sketch of each.

NOTES FOR THE TEACHER.

Leaves show an almost infinite variety both of structure and of shape. They are the breathing organs of the plant, and by their aid the plant makes organic material from its inorganic food. When all the parts are present a leaf consists of a **blade**, a **leaf-stalk**, and a **sheath** with **stipules**. In outline the blade shows every imaginable geometric form and is described accordingly. Those with a notched instead of a narrow base are described as **heart-shaped** (*cordate*), **kidney-shaped** (*reniform*), **eared** (*auriculate*), **arrow-shaped** (*sagittate*), and **spear-shaped** (*hastate*). When the leaf is joined to the stalk by some portion of its under surface, and not by its bottom edge, it is said to be **shield-shaped** (*peltate*). Leaves are also described according to the character of their top (*apex*) and of their bottom (*base*). If the blade is undivided it is said to be **entire**; if there be slight indentations of the margin the blade is said to be **crenate**, **serrate**, or **dentate**; if the indentations are considerable it is called **incised**, and if the indentations go more deeply still into the green surface so that the blade is divided into several parts it is said to be **lobed** or **partite**.

NOTES FOR COMPOSITION LESSONS

(Pupil's Composition Book, page 25.)

I. **Oral Work.**

(1) Direct the attention of the class to the pictures in their composition books.

(2) Question them regarding each picture.

(3) Insist upon each answer being given in the form of a complete sentence.

(4) Write down the answers on the black-board, and underline the words to be noted for spelling.

(5) When two answers already written have to be joined together, *first* put in the given joining word between the two sentences; *next*, strike out of the sentences words repeated needlessly; *then*, re write the new form of answer.

BLACK-BOARD

A. (1) The *stalk joins* the *leaf* to the stem of the plant.
(2) The stalk runs up the *middle* of the leaf to the *tip*.
(3) The little *branches* in the leaf are *called veins*.
(4) The stalk joins the leaf to the stem of the plant *and* runs up the middle of the leaf to the tip.

B. (1) There are *two kinds* of *leaves*.
(2) They are called *simple* and *compound*.
(3) There are two kinds of leaves, *and these* are called simple and compound.

C. (1) The *sunflower* leaf is a simple leaf.
(2) *Because* it has a *single* leaf on one stalk.
(3) The sunflower leaf is a simple leaf *because* it has a single leaf on one stalk.

D. (1) *Horse-chestnut* and *rose* leaves are compound leaves.
(2) *Because* they have *several* leaves on one stalk.
(3) Horse-chestnut and rose leaves are compound leaves *because* they have several leaves on one stalk.

II. **Spelling.**

(1) Write the underlined words on black-board.
(2) Let children give more words ending in *alk* to group with *stalk*, as *chalk*, &c. Show that *al* is sounded as *or*.

III. Written Tests.

to write the exercises with corresponding letter.

(2) Correct carefully.

MEMORANDA.


LEAVES

LEAVES. Lesson 2.

Subject Matter.	Method.
Veins.— The veins (like the stalk and the midrib) contain fibres, and are, therefore, tough; while the other portions of the leaf are soft and cellular. The fibres are the vessels by which the sap circulates. The veins generally form a network, but sometimes they are parallel.	A suitable leaf should be torn in order to show the tough and fibrous character of the veins, and the softer nature of the intermediate parts of the leaf. The arrangement of the veins should next be studied, holding the leaf up to the light and looking through it, when necessary, to render the smaller veins visible. Finally, the leaves should be classified according to their venation.
Uses of Leaves.— 1. *To the Plant.—* (*a*) They are the breathing organs of the plant. (*b*) They take in gaseous plant-food from the atmosphere. (They are provided with microscopic holes (*stomata*) to enable them to perform these functions.) (*c*) In the leaves, the sap of the plant is exposed to light and air. This causes the formation of starch, sugar, gum, and other substances required by the plant. 2. *To Ourselves.—* Many leaves are used as food (cabbage, lettuce, cress), some for making beverages (tea), and many for the preparation of drugs.	As much as possible of this information should be obtained from the class. A plant may often be killed by cutting off all its leaves. Why is this?

BLACK-BOARD SUMMARY.

Veins.— Fibrous and tough.
Sometimes form a net-work.
Sometimes parallel.

Uses.— Enable the plant to breathe.
Take in food from the air.
Expose the sap to light and air.
Used by us as food, for beverages, and for making drugs.

NOTES FOR THE TEACHER.

With regard to the distribution of the strands which traverse the green blades we distinguish between blades with a **single** main strand and blades with **several**. Blades with a single main strand are distinguished as **feather-like** (pinnate) and **radiating**. In the former the lateral strands rise successively from the main strand or midrib at almost equal intervals, and they take, at first at least, a parallel course. In radiating leaves the later strands spring directly from the main strand at the base of the blade and run like rays towards its edge. Leaf blades with **several main strands** are not nearly so varied in form and structure as those with only one, as a rule they are long-shaped with unbroken margin, and the most remarkable variations among them are in the number of strands, their thickness and their direction.

A FLOWER. Lesson I.

(Illustrated by the Buttercup.)

Requirements.—Each child should be provided with a buttercup, a small sheet of white paper on which to dissect and examine it, and a pair of large sewing needles to assist in the separation of the parts. A magnifying glass will also be useful.

(*Note.*—Several species of the order *Ranunculaceæ* are commonly known by the name of buttercup, and it is possible that the following description may not exactly apply, in one or two details, to the flower chosen for the lesson.)

Subject Matter.	Method.
Parts of a Flower.—	
A flower is made up of parts arranged in circles or whorls, commonly four in number, and the whole is generally supported on a stalk.	Each child should be provided with a buttercup, and the materials for dissecting it as mentioned above.
1. *The Stalk* (*Petiole*).—Not round, but having longitudinal angles and furrows. Long and slender.	The flower must first be examined as a whole; and then the different parts in succession. The descriptions should be given by the children as far as possible.
2. *Outer Whorl* (*Calyx* or Cup).—Consists of five green leaves called *sepals*.	
The sepals are oval, hairy, coloured at the edge, and often reflected down around the stem.	
3. *Second Whorl* (*Corolla* or Crown).—Consists of five bright-yellow leaves called *petals*. The petals are nearly round, concave, and very shiny on the upper surface.	After the petals have been examined *in situ*, they should be pulled off and further examined. An outline drawing of these and other parts should be made.
4. *Third Whorl.*—Consists of a number of *stamens*, each of which is formed of a yellow head (*anther*) mounted on a thin yellow stalk (the *filament*). The anther contains pollen grains.	The stamens should be gently pressed on white paper, and the pollen grains thus detached should be examined with a lens.
5. *Fourth Whorl* (collectively, the *Pistil*).—A cluster of small green cases (*ovaries*), each of which contains one or more seed-buds (*ovules*).	By pressing one of the ovaries under the point of a needle, the seed-bud may be squeezed out from it.

NOTES FOR COMPOSITION LESSONS

(Pupil's Composition Book, page 27.)

I. Oral Work.

(1) Direct the attention of the class to the pictures in their composition books.
(2) Question them regarding each picture.
(3) Insist upon each answer being given in the form of a complete sentence.
(4) Write down the answers on the black-board, and underline the words to be noted for spelling.
(5) When two answers already written have to be joined together, *first* put in the given joining word between the two sentences; *next*, strike out of the sentences words repeated needlessly; *then*, re-write the new form of answer.

BLACK-BOARD.

A. (1) *New plants* come from the *seeds* of the buttercup.
(2) New plants come from the *runners* of the buttercup.
(3) The new buttercup plants come from the seeds and runners of the buttercup.

B. (1) Buttercup seeds grow in *little cases*.
(2) They grow in the *centre* of the *flower*.
(3) Buttercup seeds grow in little cases in the centre of the flower.

C. (1) The *yellow leaves* of the buttercup are called *petals*.
(2) The *little stalks* inside the buttercup are called *stamens*.
(3) The yellow leaves of the buttercup are called petals, *and* the little stalks inside are called stamens.

D. (1) The buttercups grow on the *ends* of the *stalks*.
(2) *Five yellow* petals form the cup.
(3) Five small *green* leaves grow *behind* the cup.
(4) Five yellow petals form the cup, *and* five small green leaves grow behind.

II. Spelling.

(1) Write the underlined words on the black-board.
(2) *Centre.* Draw attention to the sound of the final syllable *re* (*er*). Give other examples, as *fire, fibre.*

NOTES FOR COMPOSITION LESSONS.—*Continued.*

(3) *Stalks.* Draw attention to the sound of *al* (*or*). Let children give other words ending in *alks*, as *walks*, *chalks*, &c.

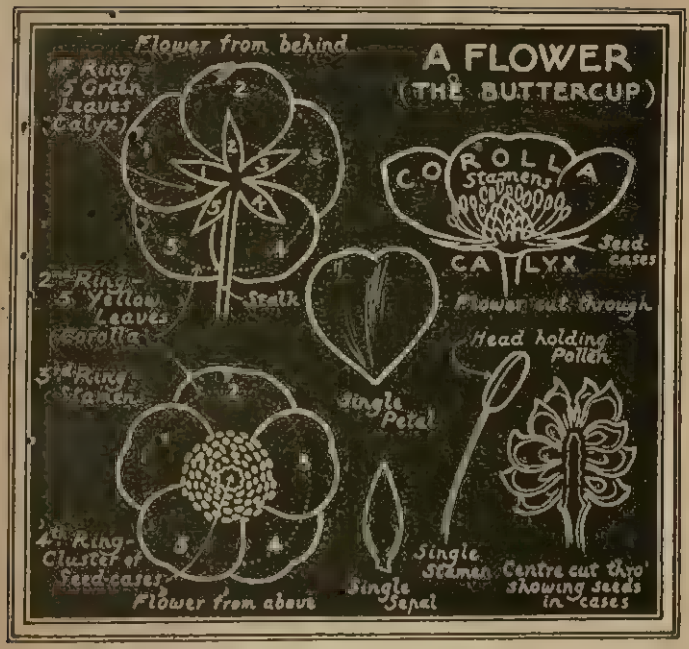
(4) Let children write out words on slates.

III. Written Tests.

(1) Clean black-board. Arrange children in groups A, B, C, D, to write the exercises with corresponding letter.

(2) Correct carefully.

MEMORANDA.



Black-Board Summary.

Parts of a Buttercup Flower.—

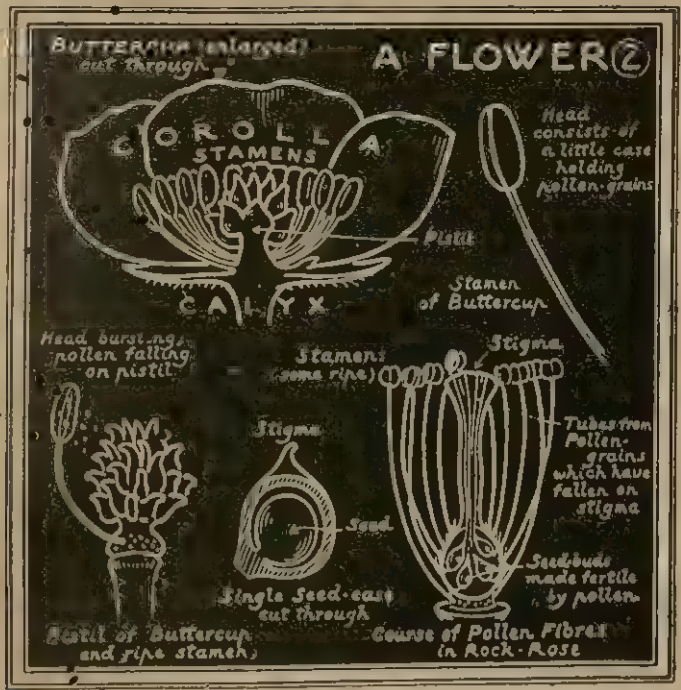
Whorls.—
- First.—The calyx—five green leaves.
- Second.—The corolla five bright-yellow leaves
- Third.—Stamens—producing the pollen.
- Fourth.—A cluster of seed-cases.

NOTES FOR THE TEACHER.

A complete flower consists of two kinds of organs, namely, **protective organs** and fruit or **seed-producing organs**. The latter are the essential parts and occupy the centre of the flower, while the blossom-leaves or floral envelopes that surround them serve merely for their preservation or the promotion of their activity. The part of the flower stem or stalk upon which all the other parts are inserted is called the **receptacle** (*torus*), and is always somewhat thicker than the rest of the flower-stalk. In some cases the thickened portion is cone-shaped and in others disc-shaped. The outer or protective organs of the flower are collectively called sometimes the **perianth** and sometimes the **perigone**, the latter name being used especially when all the perianth leaves are very much alike in shape and colour.

A FLOWER. Lesson 2.

Subject Matter.	Method.
Uses of the Various Parts.—	
1. *Stamens and Pistil.*—The stamens and the pistil are the reproductive organs of the plant—the organs by means of which the ovules are fertilized and developed. The ovules are produced in the ovaries, and fertilized by pollen from the stamens. On the summit of each ovary there is a projection, called the stigma, covered with a sticky substance. When the anthers are ripe, they burst, scattering the pollen grains. If any of these pollen grains touch the stigma, they adhere to it, and grow on it, sending fibres down into the seed-case. If these fibres come in contact with the seed-buds they fertilize them and seed is produced.	Be careful to note that the stamens and the pistil are the *essential* parts of the flower, and that the calyx and the corolla are often absent. The subject of fertilization should not be taken if it is likely to be beyond the capacities of the class to which the lesson is given.
2. *Calyx and Corolla.*—The calyx is mainly protective. It completely covers the flower-bud before it opens, and often affords great protection afterwards. The corolla is also protective. It is further useful in attracting insects, which suck sweet juices from the flowers, and assist in the distribution of the pollen, thus aiding fertilization.	Note that some flowers are almost or quite dependent on insects for the transmission of their pollen, and that such flowers have attractive corollas to lead the insects to them. If such flowers are fertilized by nocturnal insects, their corollas are white or of some light colour.
3. *Uses of Flowers to Us.*—Some used for food, as the cauliflower. Some as the camomile, for medicinal purposes. Others are used in the preparation of perfumes.	



Black-Board Summary.

Uses of the Parts.—

Calyx. — } To protect the other parts, and to attract insects.
Corolla. — }

Stamens.—The pollen of the stamens fertilizes the young seed-buds.

Seeds.—Produce new plants.

NOTES FOR THE TEACHER.

The protective organs are usually two in number, the **calyx** and the **corolla**. One or other of these may be wanting (mostly the corolla), and the calyx, though usually green, is often as highly coloured as the corolla. The stamens are called collectively the **androecium** or male household, and are usually arranged like the perianth leaves in whorls. The **carpels**, which form collectively the **gynœcium**, or female household, are also arranged in whorls; when they are rolled together and their edges are joined so as to form a capsule, the capsule is called a **pistil**: the lower and usually expanded portion of the pistil is called the **ovary**. (See notes on Buttercup, Book I.)

FRUITS. Lesson 1.

Requirements.—This lesson should be illustrated by a number of the fruits obtainable at the time. These should include, if possible, at least one of all the principal kinds. The following would make a good selection:—Fruits of pæony, pea, wallflower, poppy, dandelion, sunflower, strawberry, oak, hazel, apple, gooseberry, raspberry, currant, grape, cherry.

Fruits of a dry nature should be preserved in the school museum, so that they may be available at any time. It is advisable, too, to provide such a number that each child may have its own specimen of each kind during the lesson.

Subject Matter.	Method.
What is a Fruit?— A fruit is the ripened pistil of a flower. It consists of the seed or seeds, usually inclosed in some kind of case.	This definition should be illustrated by specimens. Thus, a series of pea flowers, showing the different stages in the development of the fruit, should be exhibited and examined.
Kinds of Fruit.— 1. *Fruits that open.*—Some fruits open when ripe, thus allowing the seeds to fall on the soil. The principal of these are: (*a*) The *follicle*—a fruit which opens on one side only, like that of the pæony. (*b*) The *legume* or *pod*, which opens on both sides, as the fruit of peas and beans. (*c*) The *capsule*—a fruit which is composed of several parts (*carpels*) united together, which separate from each other when the fruit is ripe. In some cases the separation of the parts is only partial, giving rise to a number of pores through which the seeds escape, as in the fruit of the poppy. (*d*) The *siliqua*, which has two cavities, and opens along each edge in the form of two valves. The fruit of the wallflower is of this kind.	As above suggested, each child should have the opportunity of examining all the specimens chosen to illustrate the lesson; and where any two different fruits possess characters in common, the children should be encouraged to give the points in which they resemble each other, and those in which they differ. It is advisable, too, to encourage the children to make simple outline drawings of the fruits examined; and, when necessary, sections should be made with a sharp knife in order to show the internal structure. The technical names of the kinds of fruits should not be given to the children unless they are sufficiently advanced to receive them.

NOTES FOR COMPOSITION LESSONS

(Pupil's Composition Book, page 29.)

I. Oral Work.

(1) Direct the attention of the class to the pictures in their composition books.
(2) Question them regarding each picture.
(3) Insist upon each answer being given in the form of a complete sentence.
(4) Write down the answers on the black-board, and underline the words to be noted for spelling.
(5) When two answers already written have to be joined together, *first* put in the given joining word between the two sentences; *next*, strike out of the sentences words repeated needlessly; *then*, re-write the new form of answer.

BLACK-BOARD

A. (1) One *poppy-head* grows on *each stem*.
(2) The poppy-head is called a *fruit*.
(3) It *contains seeds*.
(4) The poppy-head is called a fruit *because* it contains seeds.

B. (1) The picture shows that *currants* and *cherries* grow in *bunches*.
(2) The cherries have *long stalks*.
(3) Currants and cherries grow in bunches, *but* the cherries have long stalks.

C. (1) The *strawberry* is a *soft fruit*.
(2) Its seeds are on the *outside*.
(3) The strawberry is a soft fruit *with* its seeds on the outside.

D. (1) The seeds of the *apple* are called *pips*.
(2) They are in the *middle* of the fruit.
(3) The seeds of the apple are called pips, *and* are in the middle of the fruit.

II. Spelling.

(1) Write the underlined words on the black-board.
(2) Build up the words with more than one syllable, such as *strawberry, outside, currants*, &c.
(3) Let children supply words ending in *each*, as *teach, beach*, to group with *each*. Treat other words similarly.

NOTES FOR COMPOSITION LESSONS.—*Continued.*

(4) Draw attention to the long *u* sound of *ui* in *fruit*. Give other examples, as *suit*.

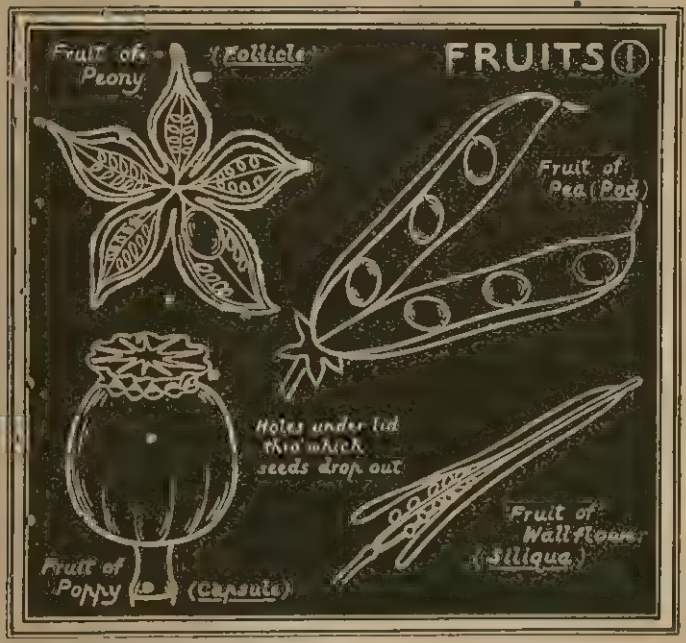
(5) Let children copy words on slates.

III. Written Tests.

(1) Clean black-board. Arrange children in groups A, B, C, D, to write the exercises with corresponding letter.

(2) Correct carefully.

MEMORANDA.



BLACK-BOARD SUMMARY.

What is a Fruit?—

The ripened pistil of a flower.

Kinds of Fruit.—

Fruits which open.

- The follicle—opens on one side.
- The pod—opens on both sides.
- The siliqua—has two cavities, and opens by two valves.
- The capsule—of several parts, which separate from each other when ripe.

NOTES FOR THE TEACHER.

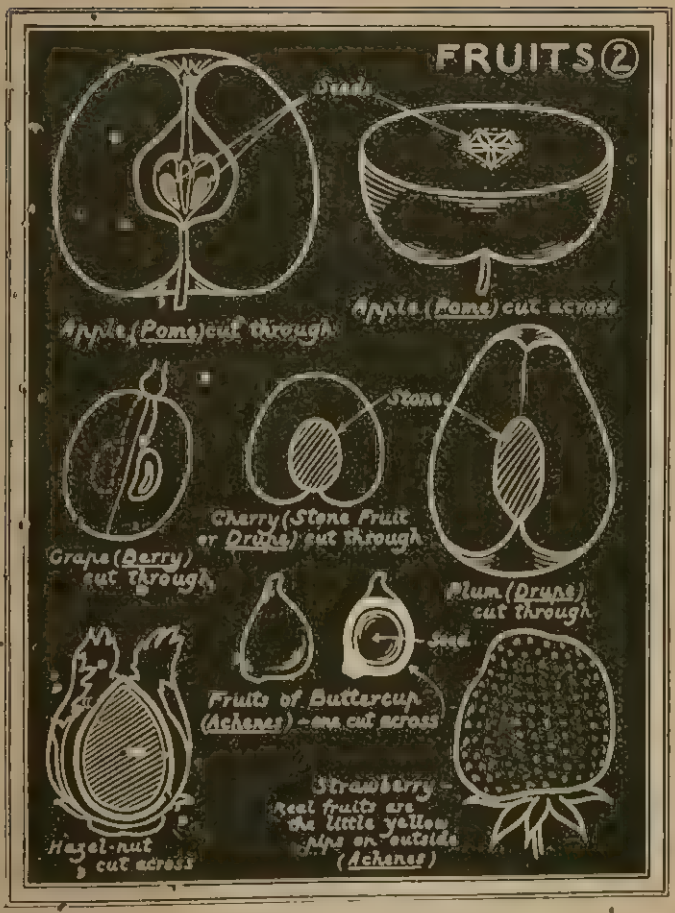
The fruit consists really of the ripened pistil and all that may be joined to it. It is the part of plants of which man makes the greatest use, the part, too, on which the continued existence of the plant is most dependent, and on which, therefore, it spends very great labour. It contains the seeds and all that is needed for their dispersal, and for their introduction into the soil under circumstances favourable to their development. Fruits are sometimes grouped as **dry** and **fleshy** fruits, and the dry fruits are further subdivided into fruits that open (*dehiscent*), and fruits that do not open (*indehiscent*). The latter are almost always one-seeded, or very few-seeded.

FRUITS Lesson 2.

Subject Matter	Method
2. *Fruits which do not open.* (b) The *berry*, a fruit in which the seeds are surrounded by a soft pulp, as the grape, gooseberry, and currant. (c) The *drupe* or *stone fruit*, in which the stone, containing the kernel or seed is surrounded by a fleshy pulpy substance—cherry, plum, and peach.	
Uses of Fruits A large number of fruits are used for food,	

NOTES FOR THE TEACHER.

simple fruits aggregate fruits collective fruits receptacle calyx pistil achenes are scattered.



BLACK-BOARD SUMMARY.

Kinds of Fruits—

Fruits which do not open.
- The pome—a fleshy fruit.
- The berry—seeds surrounded by a pulp.
- The drupe—a stone fruit.
- The nut—a dry fruit, with a hard shell, resting in a cup.
- The achene—a dry seed-like fruit.

Uses.—

For food, for flavouring, and for preparing drugs.

HOW SEEDS GROW

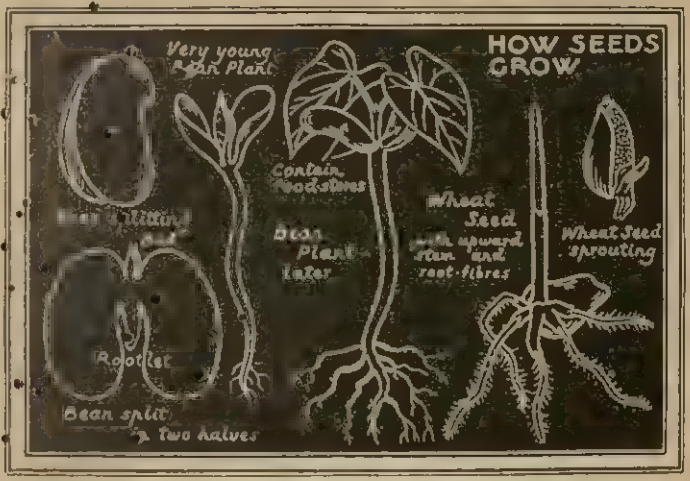
(Illustrated by the Bean and Wheat).

Requirements. About a fortnight before this lesson is to be given, a box of soil should be prepared to receive the seeds. A few grains of wheat and a few beans should then be sown, and a few more of each every day up to the time when the specimens are required. By this means a series of specimens, illustrating all the earlier stages of growth, will be ready on the day for which the lesson is arranged.

If necessary, the growth of the seed, and the development of the young plants, may be hastened by keeping the box in a warm room.

Subject Matter.	Method.
Growth of the Bean.—	
At first the bean absorbs water from the moist soil, becoming much larger and softer. The skin then splits and the young rootlet protrudes. As the rootlet increases in length, the seed itself splits into two parts, thus revealing the young bud (*plumule*), which occupied a small cavity in the closed seed. The rootlet increases rapidly in length, giving rise to branched fibres and root-hairs, which absorb food from the soil for the growing plant. At the same time the young bud grows upward, seeking light and air.	The specimens obtained as above directed are to be placed in order of their development, so that the children may observe the stages of growth in proper succession.
	The presence of much food material in the seeds may be proved by growing them in water; but elicit that the soil and the air become necessary sources of supply after the food stored up in the seeds is exhausted.
The two halves of the seed remain attached to the young plant, forming a pair of thick, fleshy leaves (*cotyledons*). These contain a large store of plant-food, by which the young plant is nourished until the root has sufficiently developed to absorb the necessary food from the soil. The function of the seed-leaves being over, they gradually shrivel, and finally drop off.	
Growth of the Wheat.—	
The grain of wheat passes through the same stages, except that the food-store of the seed gives rise to one seed-leaf only, and does not split like the bean.	The children may be encouraged to draw the young plants in their different stages from the actual specimens.

MEMORANDA.



Black-Board Summary.

Growth of the Bean.—

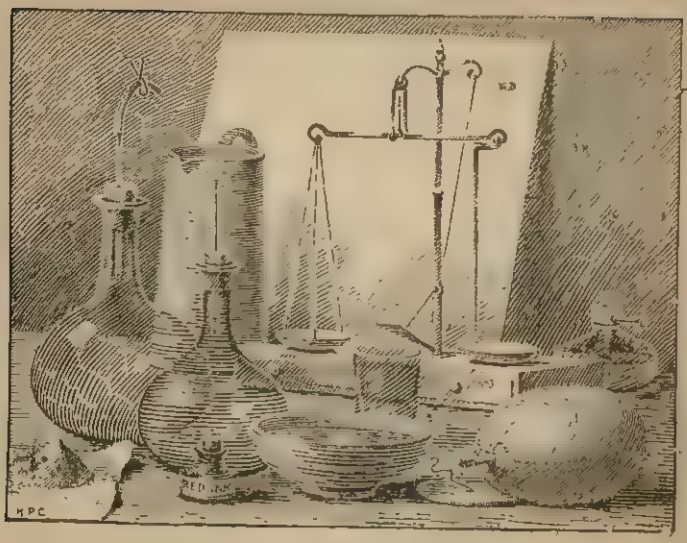
Absorbs water and swells.
Skin splits, and rootlet appears.
The seed splits, showing the young bud.
The rootlet grows downward, and the bud upward.
The halves of the seed supply food to the young plant.

Growth of the Wheat.—

Grows like the bean, but does not split.

NOTES FOR THE TEACHER.

The seed, which must be carefully distinguished from the fruit, of which it forms a part, is the fertilized **seed-bud** or **ovule**. It consists of a **nucleus** or **kernel**, inclosed generally by one or more coats, called seed-coats. The **nucleus** consists of the **embryo** or initial plantlet, surrounded by a store of nutritive matter on which it draws for nourishment, until by the help of its own roots and leaves it can supply itself. In a fully-developed embryo, that is one in which all the parts are manifest before growth begins, we can distinguish the **caulicle** or **radicle**, the **cotyledons** or **seed-leaves**, and the **plumule**, or rudiment of a primary terminal bud. The first stage of growth is seen in the lengthening of the rudimentary stem (*caulicle* or *radicle*), in its taking a vertical position, and in the development of a root from its naked end. As it issues from the seed the root end turns downward into the soil, the stem bending if necessary. While the root end avoids the light, and, protected by the root-cap (see *Lesson on Roots*), makes its way into the ground, the opposite or budding end seeks the light. The result of this lengthening of the caulicle, and passing of the root into the soil, is to carry the budding end into the air.



AIR.

Requirements.—A large light card; a tumbler; bowl of water; football bladder or air-ball; a leather "sucker"; a pair of apothecary's scales; a large glass flask, fitted with a sound cork and tube, and provided with a small stop-cock or clip; a small flask, fitted with a sound cork and straight glass tube; some fine sand; a jug of water; a little red ink; a spirit-lamp. (See illustration.)

Subject Matter.	Method.
Proofs of the Existence of Air. 1. We can feel it when it is in motion (wind), and as we breathe. 2. If we swing a large card flat-wise we can feel that resistance is offered to its motion. 3. When we inflate a bladder or an air-ball it becomes hard and resists pressure. 4. If we press an inverted tumbler down into water, the water cannot rise in the tumbler, because it is already full of something. Air occupies space.	Proofs of the existence of air should be obtained from the children; and, when the teacher performs a simple experiment, the children should be called upon to state what the experiment proves.

AIR.—*Continued.*

Subject Matter.	Method.
Properties of Air.— 1. Air is invisible (colourless), has no taste and no odour. It is a gas.	1. Compare with other gases which have colour or odour.
2. It expands readily when warmed, and contracts readily when cooled.	2. To show that air expands and contracts readily, take a small flask fitted with cork and tube. Place the end of the tube in a tumbler of water, and grasp the flask in both hands. The warmth of the hand will cause the air to expand, and some of it will bubble through the water. Then remove the hands, still keeping the tube in water. The air will contract, and water will rise in the tube. This last movement will be more distinctly seen if the water is coloured with red ink.
3. *Air has weight.*—Air is a substance (like all gases) and therefore has weight.	3. Take the large flask mentioned above (*Requirements*), and balance it exactly on the scales by means of fine sand. Now warm the flask to drive out some of the air, close the stop-cock or clip, and place it on the scales again. It now weighs less than before, therefore the air driven from it must have weight.
4. *Air presses.*—If air has weight it must exert pressure. It is the pressure of air which enables the sucker to lift a stone, and which will, under certain circumstances, prevent water from running out of an inverted vessel (see experiment opposite).	4. Illustrate by means of the sucker. Also, fill a tumbler with water, cover it with a piece of paper, and invert it. The water does not run out, the paper being pressed against the mouth of the tumbler by the air. Again, the water will not run out of the inverted tumbler as long as its mouth is kept under water.

BLACK-BOARD SUMMARY.

Proofs that Air Exists.—

We can feel it. It resists motion.

Properties of Air.—

We cannot see, taste, or smell it.
It spreads out when heated, and contracts when cooled.
It has weight.
It presses.

NOTES FOR THE TEACHER.

Pure air is without colour, taste, or smell. It is a **gas**, or rather a mixture of chiefly two gases, **nitrogen** and **oxygen**, in pretty nearly the proportion of four parts by bulk of nitrogen to one of oxygen. If you put a piece of chalk or a marble on the desk it will keep its shape; if you try to turn out a spoonful of water it at once runs down; but if you pour some into a glass it at once assumes the shape of the part of the vessel that contains it, and fills up every part of it. On the other hand, if you fill a vessel with coal-gas, and place it on the desk, you will find in a little that the gas has spread all through the room. The presence of air, though invisible, may be shown by taking two wide-mouthed vessels, filling one of them with water in the basin, then turning it upside down and raising it, taking care that the mouth does not rise above the surface. In this way the inverted vessel, full of water, may be raised up almost its full height above the surface. If now a similar vessel be thrust, mouth downward, into the water, and turned underneath the water, so that its mouth is brought under the mouth of the inverted vessel, the air in it will pass upward, displace the water, and fill the inverted vessel. Of the **expansion** of air when heated, a very striking demonstration may be given by holding a partially inflated bladder in front of a fire.

That air has weight has been proved directly by weighing a hollow glass globe filled with air, then exhausting the air by an air-pump, and reweighing, when an appreciable difference in weight was found.

WATER.

Requirements.—Jug of water; vessels of various shapes, including a tumbler, a U-tube, and a bowl; a small glass flask, fitted with a cork and a straight glass tube; red ink; a spirit-lamp; other liquids, such as mercury, spirit, &c.; salt, sugar, and alum.

Subject Matter.	Method.
Water as a Liquid.— Water, in common with other liquids, possesses the following properties:— 1. It has no fixed shape, but will readily take the form of any vessel into which it is poured. 2. It will always flow to a lower level when it is no longer supported. 3. When poured into any vessel it spreads out in all directions, and does not come to rest till its surface is quite flat and level. 4. Although its particles move freely, yet they have no tendency to spread out in *all* directions, like the particles of gases.	The properties of water should be elicited from the children as far as possible, and the differences between the properties of liquids and those of solids should be made clear. The fact that the surface of water is always level may be proved by tilting a glass vessel of water behind a lath supported horizontally, and by pouring water into a U-tube. Explain that a gas has no surface, the particles having a tendency to diffuse in all directions. Compare with other liquids to show that the properties here taken are common to all.

WATER.—*Continued.*

Subject Matter.	Method.
Other Properties of Water.—	
1. Water is colourless and transparent, tasteless and odourless.	1. Explain the meaning of these terms.
2. It expands when heated, and contracts when cooled, but not so readily as air and other gases.	2. Illustrate this property by means of the apparatus used in the last lesson for the expansion of air. The flask should be quite filled with water, coloured with red ink. Then, as the cork is pushed into its neck, the water will rise in the tube. The water may be heated by holding it for a few seconds over a spirit-lamp or a Bunsen burner.
3. It will dissolve a number of substances, such as salt, sugar, and alum.	3. Show how these substances gradually disappear when put into water.

BLACK-BOARD SUMMARY.

Water as a Liquid.—
- Has no fixed shape.
- Flows when not supported.
- Has a level surface when still.
- Its particles move freely.

Other Properties.—
- Transparent, colourless, tasteless, odourless.
- Expands when heated; contracts when cooled.
- Will dissolve many substances.

NOTES FOR THE TEACHER.

Water was long thought to be a simple substance, one of the **elements**; it is really composed of two gases—**oxygen** and **hydrogen**; but as water nearly always finds something to dissolve, absolutely pure water is scarcely met with in nature. The nearest approach to pure water that occurs is the rain-water that falls in country districts, and even that has always dissolved in it a quantity of air and of other gases. It is only when water has been distilled that it can be said to be perfectly tasteless. Water exists in all the three states—the **solid**, the **liquid**, and the **gaseous**. Though, like other bodies, it expands when heated and contracts when cooled, near the freezing point, 32° F., the regular contraction ceases and it begins to expand, so that from 39·5° to the freezing point, the cooler water being also the lighter is always on the surface. Rain-water contains no solid substance dissolved in it, but the spring-water, which has soaked through the ground, almost invariably contains lime or other solid substance dissolved in it. Water is spoken of as **soft** or **hard** according to the relative amount of lime it holds in solution. The power of water for dissolving **liquids** or **solids** is usually increased by heating it; but its power of dissolving gases is diminished by heating.

SALT.

Requirements.—Rock-salt, table-salt, picture of a salt-mine, jug of water, tumbler, stirring rod, spirit-lamp, evaporating basin on stand, test-tube, a little sea-water, fresh water.

Subject Matter.	Method.
How Obtained.—	
Common salt exists largely in the earth's crust in the form of rock-salt, which is crystalline in structure and very variable in colour. Water is allowed to run into the salt-mine. This dissolves the salt, and the solution is then pumped to the surface and evaporated. In this way table-salt is obtained from rock-salt. Common salt also exists dissolved in sea-water, and may be obtained by evaporation.	Exhibit a piece of rock-salt, and show a picture of a salt-mine. Show that salt will dissolve in water by stirring the mixture in a glass vessel. Pour a small quantity of the solution into an evaporating basin. Apply heat, and show the deposit of salt after all the water has evaporated. Evaporate a little sea-water, and show the deposit of salt. Repeat the experiment with fresh water.
Properties.—	
Salt is white and crystalline. It has a distinct taste, and will dissolve almost as readily in cold as in hot water.	Make a solution of salt in both hot and cold water, using the same quantity of salt and of water in each experiment.
After a certain quantity of salt has been dissolved in water, the water can dissolve no more, and is then said to be *saturated*.	Add salt to each solution until no more will dissolve, and show that the quantity is almost the same in the two cases.
If some of the water of a saturated solution is boiled away, a corresponding proportion of the salt will settle at the bottom.	Evaporate (partially) a portion of a saturated solution, and show the deposit of salt.
If a solution of salt is allowed to evaporate slowly, by simply leaving it exposed to air in a shallow vessel, the salt will slowly crystallize, forming regular, transparent, colourless cubes.	Set aside a saucer containing a saturated solution of salt. Let it be protected from dust, and examined by the children from day to day, until all the water has disappeared.
Salt is a valuable preservative.	

Black-Board Summary.

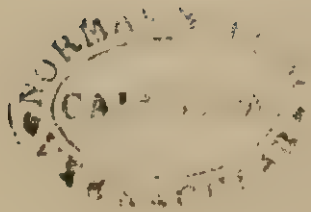
How Obtained.—

From the earth (mines).
From the sea.

Properties.—

White, crystalline, has a taste.
Dissolves in water.
Crystallizes as the water dries up.

MEMORANDA.



Rock-salt and Evaporating Basin.

NOTES FOR THE TEACHER.

Salt is usually called **common salt** to distinguish it from a large class of chemical substances, having a more or less general likeness to it in appearance or in their more easily observed qualities, and called **salts**. It is composed of the metal **sodium** and the gas **chlorine**, and its scientific name is **chloride of sodium**. When rock-salt is perfectly pure it is **colourless** and **transparent**; but it is generally found mixed with some impurities. Salt forms a very important part of the food of animals. It greatly promotes digestion, and is probably needed for the formation of the **gastric juice**. It is widely used as a **preservative** for fish, meat, &c.: it is largely used also in the manufacture of **soda** and some other chemical manufactures, and in the **glazing** of the commoner kinds of pottery. Farmers also use common salt as a manure, finding it act in some cases as a plant food, and in others as a "check", preventing the too rapid growth of the plant.

LIME AND MORTAR.

Requirements. A piece of quicklime, sand, a saucer or dish, a jug of water, a lump of chalk, a piece of limestone, a piece of marble, an evaporating basin on a stand, a spirit-lamp, a picture or model of a limekiln, a piece of old mortar, a piece of new mortar, a slab of slate, a small flat trowel.

Subject Matter.	Method.
Lime.—	
1. *Properties.* Whitish, not very hard, but very porous.	Compare with chalk, limestone and marble. Prove that it is porous by showing how it will absorb water;
It combines with water, producing great heat, and changing to a whitish powder called slaked lime.	and this same experiment will show the chemical combination of lime and water.

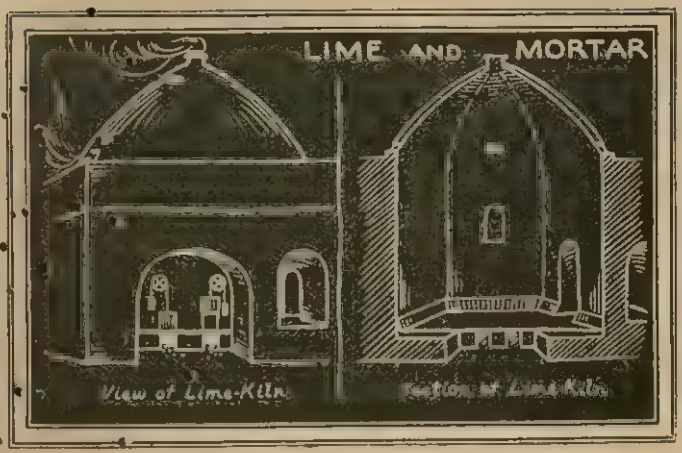
LIME AND MORTAR.—*Continued.*

Subject Matter.	Method.
If a very little lime be placed in much water, it will be partly or wholly dissolved, forming a clear solution called lime-water. Any excess of lime, which the water will not dissolve, will gradually settle at the bottom. The lime may be obtained from the clear solution by evaporating it.	Lime-water should be prepared by shaking a little lime with much water, and then allowing the excess of lime to settle at the bottom. The clear liquid may be decanted off, and a portion may be evaporated in order to prove that it has something in solution.
2. *Preparation.*—Lime is made by burning limestone, chalk, or marble in a large furnace called a kiln. A large quantity of gas (carbonic acid gas) is driven from the stone used, and lime remains. Of course there is a considerable decrease in the weight.	Show a picture or model of a lime-kiln, and explain the work of the lime-burner.
Mortar.—	
1. *Preparation.*—Mortar is prepared by adding water to lime—sufficient water to make the whole into a thick paste, which is then mixed up with sand. Sometimes hair is mixed with the soft mortar, to help it to hold together.	A small quantity of mortar should be made by the teacher before the class. For this purpose a slab of slate or a piece of board and a small plasterer's trowel may be used.
2. *Properties.*—Mortar soon "sets", or becomes a hard solid; and as it does so it will bind together two rough substances, such as two bricks, between which it is placed.	Compare a piece of new and a piece of old mortar, and show how much harder the latter is.

NOTES FOR THE TEACHER.

Lime in a perfectly pure state is a white caustic powder, consisting of **calcium** and **oxygen** (CaO). When the carbonate of lime ($CaCO_3$) is brought to a red heat the carbon dioxide (CO_2) is driven off and the lime is left. The lime in this state is known as **quicklime**, and is exceedingly greedy of moisture, which it will absorb from the atmosphere if left exposed. On account of this property it is used to prevent objects from being injured by damp. It is also used in the purifying of gas; in tanning, to remove the hairs from the hides; in the manufacture of **soda** and **potash** and bleaching-powder; in the smelting of metals, &c. It is largely used by farmers as a **plant-food**, and as a means of destroying certain organic acids which are injurious to the plants, and, generally, of increasing the fertility of the soil.

If the amount of water supplied to the quicklime be not too great, a white, dry powder, **slaked lime**, is formed. By mixing the slaked lime with sand, usually in the proportion of nearly three parts of sand to one of lime, and adding water, mortar is formed, which dries or "**sets**" sufficiently quickly to permit of a building being steadily proceeded with, and in the course of time the mortar, by the absorption of carbonic acid from the atmosphere, may become converted into a substance which will outlast the stone itself.



BLACK-BOARD SUMMARY.

Lime.

White, soft, and porous.
Combines with water, becoming hot.
Will dissolve in water.
Is made by burning limestone, chalk, or marble.

Mortar.—

Made by mixing lime and sand with water.
It soon "sets", or becomes very hard.

IRON AND STEEL.

Requirements. Specimens of wrought iron, cast iron, and steel, and articles made of each. Picture of a blast-furnace. Specimens of iron ore and slag. A hammer.

Subject Matter.	Method.
Kinds of Iron.—	
1. *Cast Iron.*—Cast iron is obtained directly from the ore in the blast-furnace, and is drawn off and cast in oblong moulds. It is very impure, containing a considerable quantity of carbon. It is crystalline in structure, brittle, and not very tenacious.	Exhibit specimens of cast iron, also a picture showing the manner of producing the cast or pig iron from the furnace. Break a thin piece of cast iron by hammering it.

IRON AND STEEL.—*Continued.*

Subject Matter.	Method.
2. *Wrought Iron.*—Wrought iron is nearly pure. It is obtained from cast iron by heating it with iron oxide in a furnace, and well stirring or puddling the liquid metal. When removed from the furnace it is rolled and squeezed. It is fibrous in structure, very tough, and tenacious.	Show specimens of wrought iron. Bend a wire of wrought iron to show that it is tough, and point out its fibrous structure after it has been broken by repeated bendings. Show the tenacity of a fine iron wire by lifting a heavy body with it.
3. *Steel.*—Steel is not so pure as wrought iron, but purer than cast iron. It may be prepared by melting together a suitable mixture of cast iron and wrought iron. It becomes very hard when suddenly cooled, and is used largely for the manufacture of cutting tools. It is also brittle and highly elastic.	Exhibit specimens of steel, such as steel wire, or a piece of clock-spring. Bend a strip or bar of steel to show its elasticity; and then increase the bending force till the steel snaps.
The Ores of Iron.— Iron is sometimes found pure in nature, but is usually combined with other substances, such as oxygen, sulphur, &c. These compounds are called the ores of iron.	Exhibit ores of iron, calling attention to the differences in their appearance and composition.
Smelting of Iron.— The iron ore is put into the blast-furnace with coal and lime; and a very high temperature is obtained by means of a blast of hot air. The carbon of the coal helps to purify the iron, and the lime combines with the earthy matter to form a fusible slag. The molten iron runs to the hearth of the furnace, and the melted slag floats on the top of it. The former is drawn off by removing a plug at the bottom, and is then cast into "pigs" or ingots.	Show a picture of the smelting furnace, and give a simple outline of the process of smelting. Specimens of slag should be shown to the class.

NOTES FOR THE TEACHER.

Pure iron is a perfectly lustrous white metal very much softer than ordinary iron. It is a curiosity only to be got in the laboratory. The metal, which is the most useful of all the metals, is abundantly distributed over the globe. Its chief ores are: **magnetic iron** or black oxide of iron, the ore for which Sweden is famous; **red hæmatite**, found in abundance in Cumberland and the north of Spain; **brown hæmatite**, found in Devonshire, the

[*Continued on page 123.*

NOTES FOR COMPOSITION LESSONS

(Pupil's Composition Book, p. 31.)

I. Oral Work.

(1) Direct the attention of the class to the pictures in their composition books.

(2) Question them regarding each picture.

(3) Insist upon each answer being given in the form of a complete sentence.

(4) Write down the answers on the black-board, and underline the words to be noted for spelling.

(5) When two answers already written have to be joined together, *first*, put in the given joining word between the two sentences; *next*, strike out of the sentences words repeated needlessly; *then*, re-write the new form of answer.

BLACK-BOARD

A. (1) We get our *iron* from iron *ore*.
(2) The iron ore is *smelted* in a *blast-furnace*.
(3) *Coal* and *lime* are burned in the furnace with the ore.
(4) We get our iron from iron ore, *which* is smelted in a blast-furnace.

B. (1) A *gallery* runs *round* the top of the furnace *outside*.
(2) The coal, and lime, and iron ore are *thrown* into the furnace from this gallery.
(3) A gallery runs round the top of the furnace outside, *and* the coal, and lime, and iron ore are thrown into the furnace from it.

C. (1) The *iron shaft* from the gallery *reaches* down to the *ground*.
(2) The coal and iron ore are *drawn* up this shaft.
(3) The iron shaft from the gallery reaches down to the ground, *and* the coal and iron ore are drawn up it.

D. (1) The *fire* is *hottest near* the *bottom* of the furnace.
(2) *Hot air* is *blown* into the furnace.
(3) The hot air is blown through *iron pipes*.
(4) Hot air is blown into the furnace through iron pipes.

II. Spelling.

(1) Write the underlined words on black-board.
(2) Draw attention to the difference in the sound of *or* when *e* is added to make *ore*. Illustrate by *for*, *fore*, *tor*, *tore*.

NOTES FOR COMPOSITION LESSONS.—*Continued.*

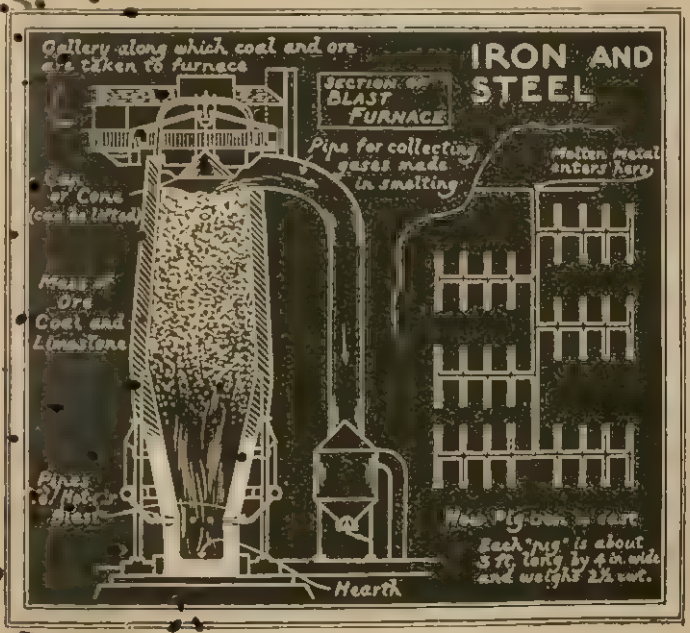
(3) *Coal.* Note the long *o* sound of *oa*. Let children give words ending in *oal* to group with *coal*, as *goal*, *foal*, &c.
(4) *Thrown, blown.* Deal with these in a similar manner to (3).
(5) Let children copy words on slates.

III. Written Tests.

(1) Clean black-board. Arrange children in groups A, B, C, &c., to write the exercises with corresponding letter.
(2) Correct carefully.

MEMORANDA.

Forest of Dean, &c.; and **carbonate of iron**, the *clay ironstone* and *blackband ironstone* so widely distributed through the coal-measures of Great Britain. **Steel** is really pure iron mixed with carbon, the qualities of the steel depending largely on the proportion the carbon bears to the iron, which may range from ¼ to 2½ per cent. The presence of other impurities—sulphur, silicon, phosphorus, &c.—lowers the quality of the steel. It is to get rid of these impurities that **cast iron** or **pig iron** has to be converted into malleable iron before being turned into steel. Steel can be made exceedingly hard, or so soft that it may be bent, rolled into plates, or drawn into wires of hair-like fineness.



Black-Board Summary.

Kinds of Iron.—

1. *Cast iron.*—Crystalline and brittle. Impure.
2. *Wrought iron.*—Tough and fibrous. Nearly pure.
3. *Steel.*—Hard, elastic, and brittle.

Ores of Iron.—

Iron is sometimes found pure.
Generally mixed with other substances.

Smelting of Iron.—

The ore is heated in a furnace with coal or coke and lime.

COPPER.

Requirements.—Copper wire of various thicknesses, copper foil, plate, and leaf. A spirit-lamp, a strong knife. Specimens of copper ore, bronze, brass, bell-metal, gun-metal, tin, and zinc.

Subject Matter.	Method.
Properties of Copper.—	
Copper is the only red metal.	Exhibit specimens of copper.
It is rather soft when pure; but, when mixed with certain other metals, it produces hard alloys.	Show that copper wire may be cut with a strong sharp penknife.
It is not elastic, like steel; but bends very easily, and is very tenacious.	Bend a piece of copper wire, and note that it does not spring back again, as steel does. Also show that a thin copper wire will support a considerable weight.
Copper is very ductile—*i.e.* may be drawn out into very fine wires; and very malleable—may be beaten or rolled into very thin sheets or leaves.	Exhibit some very fine copper wire, and also copper leaf and foil.
It is a good conductor of heat and electricity.	Hold one end of a short piece of copper wire or rod in the flame of the lamp, and show that the other end becomes hot.
It melts at a much lower temperature than iron, but at a higher temperature than either lead, tin, or zinc.	Show that a thick copper wire does not melt in the flame of a spirit-lamp, but that a *very thin* one melts slowly.
Copper does not rust, like iron, when exposed to air; but, when heated, it combines with oxygen of the air, forming a black rust or oxide, which covers the surface.	Heat a strip of copper in the flame of a lamp, and then show the covering of the black oxide formed.
The Alloys of Copper.—	
Copper forms several useful alloys with other metals, the metals being mixed when molten. The following are the principal:—	Exhibit the principal alloys of copper. Compare each one with copper, both as regards colour, and also general properties, such as hardness, elasticity, &c.
Brass.—A mixture of copper and zinc.	
Bronze.—Copper, zinc, and tin. Used for coinage.	
Bell-metal.—Copper and tin. Very sonorous.	
Gun-metal.—Copper and tin.	
Occurrence in Nature.—	
Copper is found native (unas-	Show a piece of native copper, and

MEMORANDA.

COPPER.—*Continued.*

Subject Matter.	Method.
sociated with other substances) in considerable quantities, but generally in combination with sulphur, oxygen, carbon, or other elements.	also some of the native compounds of copper; and, as far as possible, the different elements contained in these compounds.

BLACK-BOARD SUMMARY.

Properties.—
Red, rather soft, flexible, tenacious.
Ductile and malleable.
Conducts heat well.
Melts more easily than iron.
Does not rust unless heated.

Alloys.—
Brass, bronze, bell-metal, gun-metal.

Occurrence.—
Found native, and also combined with other substances.

NOTES FOR THE TEACHER.

Copper seems to have been the first metal employed by man. It takes its name from **Cyprus**, from which island the ancients seem to have obtained it. **Native** copper occurs in the mines of Russia and those in the neighbourhood of **Lake Superior**, in Canada, but the metal is chiefly found mixed with impurities. Its ores are numerous, and their smelting, or the separation of the metal from the impurities, is an important industry in South Wales. The metal is largely used. Mixed with zinc, in proportions varying from three of copper to two of zinc, to four of copper to one of zinc, it forms various kinds of brass, an easily fusible, malleable, and ductile alloy. Mixtures of copper and tin—usually with zinc or other metal also present—varying from two to twelve of the former to one of the latter, make the various alloys called **bronze**.

A TIN BOX.

Requirements.—A tin box, a magnet, a piece of sheet-iron, a block of tin, a thin bar of tin, some tin-foil, a spirit-lamp, tin ores.

Subject Matter.	Method.
A Tin Box.— A tin box is not really made of tin. It is very hard, and tin is soft. A magnet will attract a tin box, and lift it; therefore the box must be made partly of iron. The material is thin sheet-iron, covered with a thin layer of tin on both sides.	Show that the tin box is made of a very hard substance, and that a magnet will lift it. Scrape off the surface layer of tin to expose the harder metal beneath.

A Tin Box.—*Continued.*

Subject Matter.	Method.
Iron is used because of its strength; but iron rusts readily when exposed to damp air, therefore it is covered with tin, which does not rust, but always retains its bright colour.	Compare the strength and hardness of a piece of thin iron with those of a piece of tin of the same size.
Properties of Tin.— Tin is soft, but not so soft as lead, nor so heavy. It is whiter than lead. It can be rolled into a very thin sheet (tin-foil). The sheet is so soft that it can be torn or cut. Tin melts readily; and it conducts heat, but not so well as copper.	Exhibit a block of tin, and a piece of tin-foil. Compare the tin with the other metals previously examined. Cut and tear a piece of tin-foil, and melt a piece of it in a lamp or gas flame. Put the end of a small rod of tin in the flame, and show that the heat travels to the other end.
Occurrence in Nature.— Our supplies of tin are obtained chiefly from Cornwall, where it is found in combination with oxygen and other elements.	Exhibit specimens of tin ore.

Black-Board Summary.

A Tin Box.—
Made of iron.
Covered with tin.

Tin.—
Soft and white.
Melts readily.
Conducts heat.

How and Where Found.—
Found combined with other substances.
Chiefly in Cornwall.

NOTES FOR THE TEACHER.

Tin is a metal of a silvery-white colour faintly tinged with yellow. It is harder than **lead** but softer than **gold**, and can be beaten into very thin leaves as **tin-foil**. It is of great use for many purposes, because it is not readily acted upon by air or water. The foil is used for lining the inside of boxes and for wrapping up perishable articles. Tin is also used for coating the inside of cooking utensils, whether made of iron or bronze. Mixed with copper tin forms a number of very important alloys. It occurs chiefly in the form of **cassiterite** or **tinstone**; and the chief sources of the world's tin supply now are the Straits Settlements and Australia.